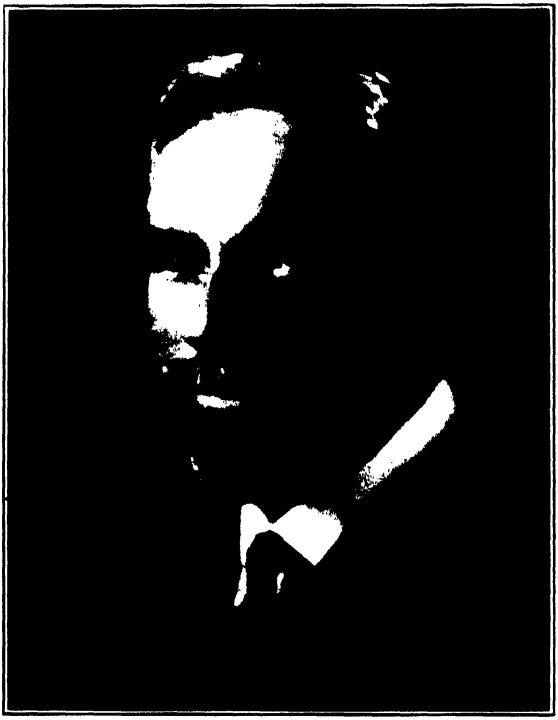

ALBERT B. REAGAN

TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE

(Founded in 1868)

VOLUME 40

F. C. GATES, *Editor*
W. J. BAUMGARTNER, *Managing Editor*

SIXTY-NINTH ANNUAL MEETING, APRIL 1, 2, 3, 1937

KANSAS STATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCE
MANHATTAN, KAN.

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ERRATA

(Directions to the recipient of the volume are in Italics)

1. *On page 397 insert in front of the title.*

"Notes on Some-"

2. *On page 399 at the end of the article add this foot-note:*

Foot-Note: "This manuscript was originally prepared in conformity with the capitalizations, etc. used in the American Orinthologists Union, Fourth Edition.

3. *Paste this paragraph on Page 400 and indicate that it should be inserted just above* "LIST OF SPECIES" *on page 401.*

As regards nomenclature, I have used several names in this paper which do not appear in Stejneger and Barbour's 1933 Check list, and there are a few proposed changes in the literature which I have not followed. The terminology used for the Amphibia is the same as that used in Smith's "Amphibians of Kansas" with the exception *Microhyla olivacea* (Hallowell). For this, I have followed Smith (1933) in regard to the specific name, and Parker (1934) in regard to the generic name. I have followed Stejneger in regard to *Leiolopisma unicolor* (Harlan), and Ortenburger (1928) in the separation of the genus *Masticophis* from *Coluber*. I have not, however, in this paper, accepted Dunn's proposal (1932) to make *Tropidoclonion* synonymous with *Thamnophis*, nor his proposal (1936) to throw *Hypsiglena* into synonymy with *Leptodeira*. I have followed Taylor (1935) in regard to the proper nomenclature for the various species and subspecies of *Eumeces*. The description of a new subspecies of the Copperhead by Gloyd and Conant (1934) automatically caused *Agkistrodon mokasen* (Beauvois(to become *Agkistrodon mokasen mokasen* (Beauvois). Dr. Burt has in his recent papers regarded *Tantilla nigriceps* as a subspecies of *Tantilla gracilis* without giving any proof of this relationship. I have followed Bishop and Schmidt (1931) as regards the status of *Chrysemys picta belli* (Gray). It seems likely that the snakes from Barber County, Kansas, reported by Burt as *Leptotyphlops dulcies* (Baird and Girard) belong to *Leptotyphlops myopica*.

TABLE OF CONTENTS

OFFICIAL

PAPERS AND ABSTRACTS

ZOÖLOGY: PAGE

CONSTITUTION AND BYLAWS

CONSTITUTION*

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in various departments of science.

SEC. 3. The membership of this Academy shall consist of three classes: annual, life and honorary.

(1) Annual members may be elected at any time by the committee on membership, which shall consist of the secretary and other members appointed, annually, by the president. Annual members shall pay annual dues of one dollar, but the secretary and treasurer shall be exempt from the payment of dues during the years of their service.

(2) Any person who shall have paid thirty dollars in annual dues, or equivalent due to legal exemption, or in one sum, or in any combination, may be elected to life membership, free of assessment, by a two-thirds vote of the members present at an annual meeting.

(3) Honorary members may be elected because of special prominence in science upon written recommendation of two members of the Academy, by a two-thirds vote of the members present. Honorary members pay no dues.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, the president-elect, a vice-president, a secretary and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, the secretary and the treasurer shall constitute the executive committee. The secretary shall be in charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting by a vote of three fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

SEC. 7. This Academy shall have an executive council consisting of the president, president-elect, the secretary, the retiring president, the editor, managing editor, and three other members to be nominated by the nominating committee and elected as the other officers. This council shall have general oversight of the Academy not otherwise given by this constitution to officers or committees.

SEC. 8. This Academy shall have an editorial board, consisting of an editor, a managing editor, and four associate editors. These members shall be elected in the same manner as other officers, but for a period of three years. Two

* As modified by amendments.

members of the board shall be elected every year, except that in 1935 the editor and one associate shall be elected for three years, the managing editor and one associate for two years and two associates for one year each.

The editor, with the aid of the associate editors, shall have general supervision of all editorial work submitted for publication in the transactions, and shall be responsible for the selecting, editing, revision and rejection of papers submitted for publication. The managing editor shall be responsible for the making of the plates and the printing and general distribution of the Transactions.

BYLAWS

I. At the beginning of each annual session there shall be held a brief business meeting for announcements and appointment of committees. For the main business meeting, held later in the session, the following order is suggested:

1. Reports of officers.
2. Reports of standing committees.
3. Unfinished business.
4. New business.
5. Reports of special committees.
6. Election of officers.
7. Election of life and honorary members.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Names of members more than one year in arrears in dues shall be dropped from the membership list.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Ten percent of the active membership shall constitute a quorum for the transaction of business. Section meetings may not be scheduled or held at the time a business meeting is called by the president at a general session or announced on the program.

VIII. The time alloted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

X. Section programs may be arranged by the secretary with the advice of the section chairmen. The subdivision or combination of existing sections shall be dependent upon the number of papers to be presented. Such changes shall be made by the secretary in accordance with the policies of the Academy and after receiving the advice of the chairmen of the sections concerned.

XI. Section chairmen for the ensuing year shall be elected annually at the close of the section meetings.

XII. Section programs shall be limited to Friday afternoon of the annual session, but may be continued Saturday afternoon if desired by the section chairman. Exceptions to this must receive the approval of the executive committee.

XIII. In selecting papers for publication in the Transactions of the Kansas Academy of Science, the editor or editorial board shall refuse papers by non-members and members who are in arrears.

PAST OFFICERS OF THE ACADEMY

Year.	President.	First Vice-president.	Second Vice-president.	Secretary.	Treasurer.
1869	B. F. Mudge	J. S. Whitman		J. D. Parker	F. H. Snow
1870	B. F. Mudge	J. S. Whitman		J. D. Parker	F. H. Snow
1871	John Fraser	B. F. Mudge		J. D. Parker	F. H. Snow
1872	John Fraser	B. F. Mudge	R. J. Brown	J. D. Parker	F. H. Snow
1873	John Fraser	B. F. Mudge	R. J. Brown	J. D. Parker	F. H. Snow
1874	F. H. Snow	J. A. Banfield	J. D. Parker	John Wherrell	R. J. Brown
1875	F. H. Snow	B. F. Mudge	J. D. Parker	John Wherrell	R. J. Brown
1876	F. H. Snow	B. F. Mudge	J. H. Carruth	Joseph Savage	R. J. Brown
1877	F. H. Snow	B. F. Mudge	J. H. Carruth	Joseph Savage	R. J. Brown
1878	F. H. Snow	B. F. Mudge	J. H. Carruth	E. A. Popenoe	R. J. Brown
1879	B. F. Mudge	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1880	B. F. Mudge	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1881	J. T. Lovewell	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1882	J. T. Lovewell	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1883	A. H. Thompson	J. R. Mead	G. E. Patrick	E. A. Popenoe	R. J. Brown
1884	R. J. Brown	F. H. Snow	Joseph Savage	E. A. Popenoe	A. H. Thompson
1885	R. J. Brown	E. L. Nichols	G. H. Failyer	E. A. Popenoe	A. H. Thompson
1886	E. L. Nichols	J. D. Parker	N. S. Goss	E. A. Popenoe	I. D. Graham
1887	J. D. Parker	J. R. Mead	E. H. S. Bailey	E. A. Popenoe	I. D. Graham
1888	J. R. Mead	E. H. S. Bailey	T. H. Dinsmore, Jr.	E. A. Popenoe	I. D. Graham
1889	T. H. Dinsmore, Jr.	E. H. S. Bailey	G. H. Failyer	E. A. Popenoe	I. D. Graham
1890	G. H. Failyer	D. S. Kelly	F. W. Cragin	E. H. S. Bailey,	I. D. Graham
1891	Robert Hay	F. W. Cragin	O. C. Charlton	E. H. S. Bailey,	F. O. Marvin
1892	E. A. Popenoe	F. O. Marvin	Mrs. N. S. Kedzie,	E. H. S. Bailey,	D. S. Kelly
1893	E. H. S. Bailey	J. T. Willard	E. B. Kneer	A. M. Collete	D. S. Kelly
1894	L. E. Sayre	I. D. Graham	J. L. Howitt	E. B. Kneer	D. S. Kelly
1895	Warren Knaus	I. D. Graham	S. W. Williston	E. B. Kneer	D. S. Kelly
1896	D. S. Kelly	S. W. Williston.	D. E. Lantz	E. B. Kneer	L. E. Sayre
1897	S. W. Williston	D. E. Lantz	A. S. Hitchcock	E. B. Kneer	J. W. Beede
1898	D. E. Lantz	C. S. Parmenter	L. C. Wooster	E. B. Kneer	J. W. Beede
1899	E. B. Kneer	A. S. Hitchcock	J. R. Mead	D. E. Lantz	J. W. Beede
1900	A. S. Hitchcock	E. Miller	J. C. Cooper	D. E. Lantz	J. W. Beede
1901	E. Miller	J. C. Cooper	L. C. Wooster	D. E. Lantz	E. C. Franklin
1902	J. T. Willard	Edward Bartow	J. A. Yates	G. P. Grimsley,	E. C. Franklin
1903	J. C. Cooper	Edward Bartow	J. A. Yates	G. P. Grimsley,	Alva J. Smith
1904	Edward Bartow	L. C. Wooster	B. F. Eyer	G. P. Grimsley,	Alva J. Smith
1905	L. C. Wooster	F. W. Bushong	W. A. Harshbarger,	J. T. Lovewell	Alva J. Smith
1906	F. O. Marvin	B. F. Eyer	J. E. Welin	J. T. Lovewell	Alva J. Smith
1907	J. A. Yates	E. Haworth	F. B. Dains	J. T. Lovewell	Alva J. Smith
1908	E. Haworth	F. B. Dains	J. M. McWharf	J. T. Lovewell	Alva J. Smith
1909	F. B. Dains	J. M. McWharf	Alva J. Smith	J. T. Lovewell	F. W. Bushong
1910	F. B. Dains	J. M. McWharf	Alva J. Smith	J. T. Lovewell	F. W. Bushong
1911	J. M. McWharf	Alva J. Smith	J. E. Welin	J. T. Lovewell	F. W. Bushong
1912	F. W. Bushong	Alva J. Smith	J. E. Welin	J. T. Lovewell	L. D. Havenhill
1913	Alva J. Smith	W. A. Harshbarger,	J. A. G. Shirk	J. T. Lovewell	L. D. Havenhill
1914	W. A. Harshbarger,	J. A. G. Shirk	J. E. Todd	J. T. Lovewell	L. D. Havenhill
1915-'16	J. A. G. Shirk	J. E. Todd	F. U. G. Agrelius,	J. T. Lovewell	L. D. Havenhill
1916-'17	J. E. Todd	F. U. G. Agrelius,	L. D. Havenhill	W. W. Swingle	W. A. Harshbarger
1917-'18	F. U. G. Agrelius	L. D. Havenhill	B. M. Allen	W. W. Swingle W. K. Swingle, Guy West Wilson	W. A. Harshbarger
1918-'19	L. D. Havenhill	R. K. Nabours	B. M. Allen	Guy West Wilson	F. C. Bruckmiller
1919-'20	R. K. Nabours	B. M. Allen	O. P. Dellinger	E. A. White	L. D. Havenhill
1920-'21	O. P. Dellinger	Roy Rankin	W. P. Hays	E. A. White	L. D. Havenhill
1921-'22	Roy Rankin	R. K. Nabours	W. R. B. Robertson	E. A. White	L. D. Havenhill
1922-'23	R. K. Nabours	H. P. Cady	H. H. Nininger	E. A. White	L. D. Havenhill
1923-'24	H. P. Cady	H. H. Nininger	J. E. Ackert	E. A. White	L. D. Havenhill
1924-'25	H. H. Nininger	J. E. Ackert	F. U. G. Agrelius	E. A. White	L. D. Havenhill
1925-'26	J. E. Ackert	H. M. Elsey	W. M. Goldsmith	E. A. White	L. D. Havenhill
1926-'27	H. J. Harnly	Mary T. Harman,	L. D. Wooster	E. A. White	L. D. Havenhill
1927-'28	Mary T. Harman,	L. D. Wooster	W. B. Wilson	E. A. White	L. D. Havenhill
1928-'29	L. D. Wooster	W. B. Wilson	Hazel E. Branch	G. E. Johnson	L. D. Havenhill
1929-'30	W. B. Wilson	Hazel E. Branch	W. M. Goldsmith,	G. E. Johnson	R. Q. Brewster
1930-'31	Hazel E. Branch	Roger C. Smith	W. H. Matthews	G. E. Johnson	R. Q. Brewster
1931-'32	Roger C. Smith	W. J. Baumgartner	J. W. Hershey	G. E. Johnson	R. Q. Brewster
1932-'33	Robert Taft	J. W. Hershey	W. H. Matthews	G. E. Johnson	H. A. Zinszer
1933-'34	J. W. Hershey	W. H. Matthews	E. A. Marten	G. E. Johnson	H. A. Zinszer
1934-'35	W. H. Matthews	E. A. Marten	W. J. Baumgartner	G. E. Johnson F. C. Gates.	H. A. Zinszer
1935-'36	W. J. Baumgartner	L. Oncley	H. H. Hall	Roger C. Smith,	H. A. Zinszer
1936	L. Oncley	G. A. Dean	W. H. Schoewe	Roger C. Smith,	H. A. Zinszer

NOTE.—Previous to 1931-'32 the secretary was also editor. Since 1931-'32 F. C. Gates has been editor.

MEMBERSHIP OF THE ACADEMY

May 1, 1937

ABBREVIATIONS: The following abbreviations for institutions have been used:

U. of K.: University of Kansas.
K. S. C.: Kansas State College of Agriculture and Applied Science.
K. S. T. C.: Kansas State Teachers College.
F. H. K. S. C.: Fort Hays Kansas State College.
H. S.: High School.
Jr. H. S.: Junior High School.
Jr. Col.: Junior College.

Other abbreviations follow those used in the Summarized Proceedings of the American Association for the Advancement of Science.

The year given indicates the time of election to membership.

HONORARY MEMBERS

Barber, Marshall A., Ph. D., 1904, Internat. Health Div., Rockefeller Found., 49 W. Forty-ninth street, New York, N. Y.

Cockerell, T. D. A., D. Sc., 1908, prof. zoölogy (emeritus), Univ. Colorado, Boulder, Colo.

Grimsley, G. P., Ph. D., 1896, geological eng., B. & O. R. R., 4405 Underwood Road (Guilford), Baltimore, Md.

Kellogg, Vernon L., LL. D., Sc. D., 1920, permanent secretary emeritus, National Research Council, Washington, D. C. (2305 Bancroft Place.)

McClung, C. E., Ph. D., 1903, dir. zoölogy lab., Univ. Pennsylvania, Philadelphia, Pa.

McCollum, E. V., Ph. D., Sc. D., 1902, prof. biochemistry, Johns Hopkins Univ., Baltimore, Md.

Nichols, Edward L., Ph. D., Sc. D., 1885 (honorary member 1897), prof. physics (emeritus). Cornell Univ., Ithaca, N. Y.

Riggs, Elmer S., M. A., 1896, assoc. curator paleontology, Field Mus. Nat. Hist., Chicago, Ill.

Wagner, George, M. A., 1897 (honorary member 1904), prof. zoölogy, Univ. Wisconsin, Madison, Wis.

LIFE MEMBERS

Agrelius, Frank U. G., M. A., 1905, assoc. prof. biol., K. S. T. C., Emporia, Kan.

Allen, Herman Camp, Ph. D., 1904, prof. chemistry, U. of K., Lawrence, Kan.

Bartow, Edward, Ph. D., Sc. D., 1897, prof. and head Dept. Chem. and Chem. Eng., State Univ. Iowa, Iowa City, Iowa.

Baumgartner, William J., Ph. D., 1904, prof. zoölogy, U. of K., Lawrence, Kan.

Beede, Joshua W., Ph. D., 1894, prof. geology and paleontology, Indiana Univ., Bloomington, Ind.

Berry, Sister M. Sebastion, A. B., 1911, Supt. Schools, St. Paul, Kan.

Bushnell, Leland D., Ph. D., 1908, prof. and head Bacteriology Dept., K. S. C., Manhattan, Kan.

Bushong, F. W., Sc. D., 1896, 2636 Fifth street, Port Arthur, Tex.

Cady, Hamilton P., Ph. D., 1904, prof. chemistry, U. of K., Lawrence, Kan.

Cook, W. A., M. S., 1907, real estate business, 1414 Highland street, Salina, Kan.

Copley, Rev. John T., 1908, Olathe, Kan.

Cragin, F. W., Ph. D., 1880, 912 Miguel street, Colorado Springs, Colo.

Dains, Frank Burnett, Ph. D., 1902, prof. chemistry, U. of K., Lawrence, Kan.

Dean, George A., M. S., 1903, 1912, head Dept. Ent., K. S. C., Manhattan, Kan.

Deere, Emil O., M. S., 1905, dean and prof. biology, Bethany Col., Lindsborg, Kan.

Dellinger, Orris P., Ph. D., 1900, prof. biology, K. S. T. C., Pittsburg, Kan.

Dunlevy, R. B., M. A., 1896, Southwestern Col., Winfield, Kan.

Eby, J. Whit, B. S., 1903, banker, Howard, Kan.

Failyer, George H., M. S., 1878, retired, R. R. 4, Manhattan, Kan.
Faragher, Warren F., Ph. D., 1927, director of research, Catalytic Dev. Co., 1608 Walnut street, Philadelphia, Pa.
Garrett, A. O., M. A., 1901, head Dept. Biology, East High School, Salt Lake City, Utah.
Graham, I. D., M. S., 1879, State Board of Agric., Topeka, Kan.
Harman, Mary T., Ph. D., 1912, prof. zoölogy, K. S. C., Manhattan, Kan.
Harnly, Henry J., Ph. D., 1898, prof. biology, McPherson Col., McPherson, Kan.
Harshbarger, William A., Sc. D., 1903, prof. mathematics, Washburn Col., Topeka, Kan.
Havenhill, L. D., Ph. C., 1904, dean School of Pharmacy, U. of K., Lawrence, Kan.
King, H. H., Ph. D., 1909, prof. and head Dept. Chemistry, K. S. C., Manhattan, Kan.
Knaus, Warren M., D. Sc., 1882, entomologist, editor *Democrat Opinion,* McPherson Kan.*
Meeker, Grace R., 1899, 709 S. Mulberry, Ottawa, Kan.
Menninger, C. F., M. D., 1903, 3617 W. Sixth avenue, Topeka, Kan.
Nabours, Robert K., Ph. D., 1910, prof. and head Zoölogy Dept., K. S. C., Manhattan, Kan.
Nissen, A. M., A. B., 1888, farmer, Wetmore, Kan.
Peace, Larry M., 1904, 512 W. Ninth street, Lawrence, Kan.
Reagan, (Mrs.) Otilla, 1937, 177 E. Fourth street North, Provo, Utah.
Robertson, W. R. B., Ph. D., 1905, Anat. Dept., Univ. Iowa, Iowa City, Iowa.
Schaffner, John H., M. S., 1903, research and prof. botany, Ohio State Univ., Columbus, Ohio.
Scheffer, Theodore, M. A., 1903, assoc. biologist, U. S. Biological Survey, Puyallup, Wash.
Shirk, J. A. G., 1904, prof. mathematics, K. S. T. C., Pittsburg, Kan.
Smith, Alva J., 1892, consulting eng., 810 Boylston street, Pasadena, Cal.
Smyth, E. Graywood, 1901, entomologist, Cia. Agricola Carabayllo, Hacienda Cartavio, Trujillo, Peru.
Smyth, Lumina C. R., Ph. D., 1902, 16802 Dartmouth, Cleveland, Ohio.
Sterling, Charles M., A. B., 1904, Lawrence, Kan. (Deceased.)
Sternberg, Charles H., M. A., 1896, 4046 Arizona street, San Diego, Cal.
Stevens, Wm. C., 1890, head Botany Dept., U. of K., Lawrence, Kan.
Welin, John Eric, D. Sc., 1889, prof. chemistry, Bethany Col., Lindsborg, Kan.
Wells, J. Ralph, Ph. D., 1934, prof. biology, K. S. T. C., Pittsburg, Kan.
White, E. A., M. A., 1904, prof. chemistry, U. of K., Lawrence, Kan.
Willard, Julius T., D. Sc., 1883, vice-president K. S. C., Manhattan, Kan.
Wilson, William B., Sc. D., 1903, head Biology Dept., Ottawa Univ., Ottawa, Kan.
Wooster, Lyman C., Ph. D., 1889, 1017 Union street, Emporia, Kan.

ANNUAL MEMBERS

Members who paid their 1937 dues before May 1, 1937, are indicated by an asterisk (*). The year given is that of election to membership. If two years are given the second signifies reëlection.

*Ackert, James E., Ph. D., 1919, prof. zoölogy, parasitology, dean Graduate Div., K. S. C., Manhattan, Kan.
*Aicher, L. C., B. A., 1930, supt. Fort Hays Branch, K. S. Agr. Expt. Sta., Hays, Kan.
*Albertson, F. W., 1935, assoc. prof. bot., F. H. K. S. C., Hays, Kan.
*Albright, Penrose S., M. S., 1926, asst. prof. physics and chem., Southwestern Col., Winfield, Kan.
*Aldous, A. E., Ph. D., 1937, prof. pasture improvement, K. S. C., Manhattan, Kan.
*Allegre, Charles, 1935, teacher, Osage City, Kan.
Allen, Evelyn Helen, 1936, U. of K., Lawrence, Kan.
Aller, Alvin R., M. S., 1932, 607 E. Sixteenth street, Hutchinson, Kan.
*Allsbury, Carl, student, 1937, K. S. T. C., Emporia, Kan.
*Alm, O. W., Ph. D., 1931, assoc. prof. psychology, K. S. C., Manhattan, Kan.
*Alsop, Annette, student, 1937, K. S. C., Manhattan, Kan.
*Alsop, M. L., M. S., 1932, teacher, H. S., Wamego, Kan.
*Ameel, Donald J., Sc. D., 1937, inst. zoölogy, K. S. C., Manhattan, Kan.
*Angell, Wenonah E., 1936, student K. S. T. C., Medicine Lodge, Kan.
Askren, Edward L., Jr., 1936, 1220 Moro, Manhattan, Kan.
Aquinas, Sister M., 1934, St. John's Academy, Wichita, Kan.
*Atkeson, F. W., M. S., 1937, head dairy dept., K. S. C., Manhattan, Kan.

*Deceased.

*Atkinson, Esther, M. S., 1937, instr. home economics, McPherson Col., McPherson, Kan.
*Aubel, C. E., Ph. D., 1933, assoc. prof. animal husbandry, K. S. C., Manhattan, Kan.
Ayers, H. D., Ph. D., 1928, head Dept. Physics, Univ. Wichita, Wichita, Kan.
Ayers, Jane L., A. B., 1935, asst. botany, Washburn Col., Topeka, Kan.
*Ayers, John C., A. B., 1936, Dept. Zoöl., Duke Univ., Durham, N. Carolina.
*Babcock, Rodney W., Ph. D., 1931, dean div. gen. science, K. S. C., Manhattan, Kan.
*Baden, Martin W., Sc. D., 1921, box 520, Winfield, Kan.
Baker Burton L., A. B., 1934, 630 West 168th St., New York City.
*Baldwin, Alfred S., M. A., 1937, Dept. Psychology, U. of K., Lawrence, Kan.
*Bardo, Carol, A. B., 1933, lab. technician, suite 14, Arcade bldg., Arkansas City, Kan.
*Barnett, R. J., M. S., 1922, prof. hort., K. S. C., Manhattan, Kan.
*Barnhart, Carl, B. S., 1932, instr. H. S East, Wichita, Kan.
Bartholic, Robert L., A. B., student, R. 1, Hays, Kan.
*Barton, A. W., Ph. D., 1928, head of Botany Dept., F. H. K. S. C., Hays, Kan.
Bates, James, M. A., 1933, asst. instr. botany, K. S. C., Manhattan, Kan.
Bayles, Ernest E., M. A., 1930, assoc. prof. educ., U. of K., Lawrence, Kan.
*Beach, Edith, M. A., 1931, teacher, 812 Illinois street, Lawrence, Kan.
Beamer, Raymond H., Ph. D., 1936, Dept. Ent., U. of K., Lawrence, Kan.
Beck, James Theodore, M. A., 1936, instr. Lane Col., Jackson, Tenn.
Bell, John W., B. S., 1935, instr. ind. arts., H. S., Walton, Kan. (Mail returned.)
*Bennett, Dewey, M. A., 1928, instr. biology and chem., Jr. Col., Garden City, Kan.
*Bergstresser, Karl S., Ph. D., 1937, head Chem. Dept., Ottawa Univ., Ottawa, Kan.
*Bernhart, Arthur, Ph. D., 1937, instr. math. and physics, Ottawa Univ., Ottawa, Kan.
*Blackman, L. E., Ph. S., 1935, head, Dept. Chem., K. S. T. C., Emporia, Kan.
Bogart, Ralph, B. S., 1936, Dept. Genetics, Cornell Univ., Ithaca, N. Y.
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*Rarick, Lawrence, M. S., 1936, F. H. K. S. C., Hays, Kan.
Reed, Homer B., Ph. D., 1936, prof. psych., F. H. K. S. C., Hays, Kan.
*Reid, W. Malcolm, B. S., 1936, Dept. Zoöl., K. S. C., Manhattan, Kan.
*Richard, Brooks C., 1936, F. H. K. S. C., Hays, Kan.
*Rizzo, Nicholas D., M. S., Dept. Educ., Harvard Univ.
*Rogers, Cornelius, B. S., 1935, Dept. Ent., K. S. C., Manhattan, Kan.
*Rolfs, Marvin E., M. S., 1937, instr. in physics, Dodge City Jr. Col., Dodge City, Kan.
Roosevelt H. S., Science Classes, Emporia, Kan.
*Rouse, J. E., M. S., 1928, prof. agric., F. H. K. S. C., Hays, Kan.
*Ruff, Charles E., B. S., 1937, teacher, H. S., Kingman, Kan.
*Ruggles, Geo. E., 1936, K. S. T. C., Pittsburg, Kan.
Runyon, H. Everett, 1935, F. H. K. S. C., Hays, Kan.
Russell, Ned M., M. A., 1936, 1622 Kentucky, Lawrence, Kan.
*Saffrey, Olga B., M. S., 1937, grad. student, K. S. C., Manhattan, Kan.
*Sanders, Ottys, A. B., 1934, Southwestern Biol. Sup. Co., P. O. box 4084, Dallas, Tex.
Sarracino, John, B. S., 1928, box 295, Neodesha, Kan. (Mail returned.)
Schaefer, Helen I., 1935, 1220 Market street, Emporia, Kan.
*Schaffner, D. C., A. M., 1931, geology and botany, Col. of Emporia, Emporia, Kan.
Schellenberg, P. E., Ph. D., 1936, Bethel Col., Bethel, Kan.
*Schmidt, J. M., 1934, 1937, Tabor Col., Hillsboro, Kan., (renewal).
*Schoewe, Walter H., Ph. D., 1925, assoc. prof. geology, U. of K., Lawrence, Kan.
*Schovee, Joseph C., 1928, asst. eng. A. T. & S. F. R. R., 1235 Boswell avenue, Topeka, Kan.
*Schrader, William B., M. A., 1937, instr. Dept. Educ., K. S. C., Manhattan, Kan.
*Schrammel, H. E., Ph. D., 1929, prof. psych., K. S. T. C., Emporia, Kan.
Schultis, W. J., B. S., 1936, McPherson, Kan.
*Schultz, P. D., M. S., 1937, Dept. Chem., Friends Univ., Wichita, Kan.
*Schwartz, J. D., M. S., 1937, Dept. Biochem., Dodge City Jr. Col., Dodge City, Kan.
*Schumann, Margaret, M. A., 1922, technician, Dept. Anatomy, U. of K., Lawrence, Kan.
*Seaton, Roy A., M. S., 1928, dean, Div. Engr., K. S. C., Manhattan, Kan.
*Shaffer, H. Lloyd, A. B., 1931, grad. asst. geol., U. of K., Lawrence, Kan.
*Shawnee Mission Rural H. S., Science Club, 1932, sponsor, Jas. C. Hawkins, Merriam, Kan.
*Shepherd, B. L., M. S., 1937, 1239 S. Atlanta avenue, Tulsa, Okla.
Sherwood, Noble P., Ph. D., 1935, prof. bact., U. of K., Lawrence, Kan.
*Sites, Blaine E., B. S., 1932, teacher phys. and chem., H. S., Salina, Kan.
*Smedley, Melbern, 1936, student, K. S. C., Manhattan, Kan.
*Smith, Charles Lewis, student, 1937, K. S. T. C., Hays, Kan.
*Smith, Hobart M., M. S., 1932, Dept. Zoöl., U. of Michigan, Ann Arbor, Mich.
*Smith, H. T. U., Ph. D., 1937, asst. prof. geology, U. of K., Lawrence, Kan.
*Smith, Roger C., Ph. D., 1921, prof. ent., K. S. C., Manhattan, Kan.

*Smith, V. T., Ph. D., 1937, Kansas Wesleyan Univ., Salina, Kan.
Snyder, Dorrice, A. B., 1935, asst. psychologist, child res. lab., Friends Univ., Wichita, Kan.
*Sperry, Arthur B., B. S., 1917, 1922, prof. geology, K. S. C., Manhattan, Kan.
*Stebbins, Florence M., M. S., 1933, asst. genetics, K. S. C., Manhattan, Kan.
Stephens, Homer A., 1936, 320 Santa Fe, Atchison, Kan.
*Stephenson, Lyle, 1932, 118 E. Tenth street, Kansas City, Mo.
*Sternberg, Charles W., 1936, 6146 Dorchester, Chicago, Ill.
*Sternberg, George F., M. S., (Hon.) 1928, field vertebrate paleontologist, F. H. K. S. C., Hays, Kan.
Stone, R. G., Ph. D., 1936, prof. zoöl., U. of K. C., Kansas City, Mo.
*Stouffer, E. B., Ph. D., 1929, dean, Grad. School, U. of K., Lawrence, Kan.
*Stout, Eva., 1937, field visitor, 1825 Maple, Wichita, Kan.
*Stroud, J. B., Ph. D., 1932, Dept. Psych. and Phil., K. S. T. C., Emporia, Kan.
*Stogsdill, J. W. F. (renewal 1937), Dept. Physics, H. S. East, Wichita, Kan.
*Studt, Charles W., M. S., 1928, Sagamore Oil & Gas Co., Independence, Kan.
*Summerland, S. A., M. S., 1937, U. S. D. A., 808 State street, Vincennes, Ind.
*Sutter, L. A., M. D., 1923, physician, 611 First National Bank Bldg., Wichita, Kan.
*Swain, Fred M., A. B., 1937, student, U. of K., Lawrence, Kan.
*Swanson, Arthur F., M. S., 1926, agronomist, Branch Expt. Sta., Hays, Kan.
*Taft, Robert, Ph. D., 1923, 1929, assoc. prof. chem., U. of K., Lawrence, Kan.
*Talbott, W. A., Jr., 1935, Underhill Terminix Co., 325 N. Waco street, Wichita, Kan.
*Taylor, Edward H., Ph. D., 1928, assoc. prof. zoöl., U. of K., Lawrence, Kan.
*Terry, Lyman, student, 1937, U. of K., Lawrence, Kan.
*Thomas, Lawrence C., Ph. D., 1932, head Dept. Biol., Kansas Wesleyan Univ., Salina, Kan.
*Thomas, George L., Jr., A. B., 1937, Dept. Chem., F. H. K. S. C., Hays, Kan.
*Thompson, D. Ruth, M. A., 1928, prof. chem., Sterling Col., Sterling, Kan.
*Thompson, Rufus H., A. B., 1934, Dept. Botany, U. of K., Lawrence, Kan.
*Thompsen, Lillian C., Ph. D., 1937, teacher biol., Bethany College, Lindsborg, Kan.
*Tiemeier, Otta W., A. B., 1937, museum asst., U. of K., Lawrence, Kan.
*Tihen, Joe A., 1936, Harper, Kan.
*Torstveit, Olaf, B. A., 1937, Dept. Zoöl., K. S. C., Manhattan, Kan.
*Travis, Gerald, B. S., 1937, principal Norton H. S., Norton, Kan.
*Trimmell, John A., M. S., 1936, box 656, Hutchinson, Kan. (Mail returned.)
Turner, Clair K., A. M., 1936, head Dept. Health Educ., K. S. T. C., Emporia, Kan.
*Unruh, Earl W., student, 1937, Bethel Col., Bethel Kan.
Vandervelde, Conrad, B. D., 1937, dean psychol., Emporia, Kan.
Van Wormer, Fay, 1936, rural mail carrier, Osborn, Kan.
Varvel, Walter A., M. A., 1936, Dept. Psych., U. of K., Lawrence, Kan.
*Voth, Albert C., 1936, student, U. of K., Lawrence, Kan.
Voth, Arnold, 1932, teacher, Moundridge, Kan.
*Walters, Philip, 1937, grad. student, Dept. Geol., K. S. C., Manhattan, Kan.
*Waring, Sister Mary Grace, Ph. D., 1932, head Dept. Science, Marymount Col., Salina, Kan.
*Warner, Robert W., E. E., 1935, prof. elect. engr., U. of K., Lawrence, Kan.
*Warnock, W. G., Ph. D., 1936, asst. prof. math., F. H. K. S. C., Hays, Kan.
*Washburn, E. Roger, Ph. D., 1937, Dept. Chem., U. of Neb., Lincoln, Neb.
*Way, P. Ben., B. Sc., 1932, teacher H. S. North, Wichita, Kan.
Weathers, Edna, 1936, child res. lab., Wichita, Kan.
*Weaver, Virgil L., B. S., 1937, asst. instr., U. of K., Lawrence, Kan.
*Weber, A. D., M. S., 1937, Dept. Animal Husb., K. S. C., Manhattan, Kan.
*Weber, Clement, 1928, box 186, Selden, Kan.
*Weber, Louis R., Ph. D., 1929, head Dept. Physics, Friends Univ., Wichita, Kan.
Weber, Wallace, B. S., 1936, 1113 Congress, Emporia, Kan. (Mail returned.)
*Weeks, Elvira, Ph. D., 1927, asst. prof. chem., U. of K., Lawrence, Kan.
*Weidlein, Edward Ray, Sc. D., 1911, dir. Mellon Inst. Ind. Res., Pittsburgh, Pa.
Welch, Bernard H., 1936, Dept. Zoöl., U. of K., Lawrence, Kan.
Westgate, E. W., 1936.
*Wetmore, Alexander, 1935, asst. sec. Smithsonian Inst., U. S. Nat. Museum, Washington, D. C.
*Wheeler, R. H., Ph. D., 1936, head Dept. Psych., U. of K., Lawrence, Kan.
Whelan, Don B., M. S., Dept. Ent., Col. of Agric., Lincoln, Neb.
*White, Wayne E., Ph. D., 1937, 312 Ninth St., Oakmont, Pa.

*Whitnah, Carroll H., Ph. D., 1936, chemist, K. S. C., Manhattan, Kan.
*Whitla, Raymond E., A. B., asst. geol., U. of K., Lawrence, Kan.
*Wichita City Library, 1932, Ruth E. Hammond, librarian, Wichita, Kan.
*Wichita H. S. East Chemistry Club, 1934, sponsor, Carl Barnhardt, Wichita, Kan.
*Wilbur, Donald A., M. A., 1934, asst. prof. ent., K. S. C., Manhattan, Kan.
*Wildish, Myra, A. B., 1936, 115 N. Lawn street, Kansas City, Mo.
Williams, John R., M. S., 1936, K. S. T. C., Emporia, Kan.
Wimmer, E. J., Ph. D., 1928, asst. prof. zoöl., K. S. C., Manhattan, Kan.
*Wismer, C. A., M. S., 1933, care of University Farm, St. Paul, Minn.
Wismer, Nettie M., M. S., 1932, science teacher, Jr. H. S., Lawrence, Kan.
*Witherspoon, Ward, A. B., 1936, teacher, Junior Col., Dodge City, Kan.
Wolfson, Charles, M. A., 1935, asst. zoöl., U. of K., Lawrence, Kan.
*Wood, Robert E., M. S., 1930, chemistry, Liberty Memorial H. S., Lawrence, Kan.
*Wong, Wai-Sing, M. S., 1937, student, K. S. C., Manhattan, Kan.
*Wooster, Lyman C., Ph. D., 1924, prof. zoöl., F. H. K. S. C., Hays, Kan.
Yoder, J. J., LL. D., 1926, prof sociol., McPherson Col., McPherson, Kan.
*Young, H. D., 1935, assoc. chemist, U. S. D. A., Manhattan, Kan.
*Zinszer, Harvey A., Ph. D., 1930, prof. physics and astron., F. H. K. S. C., Hays, Kan.
*Zinszer, Richard H., B. S., 1931, 521 Avalon Apts., Avalon Ave., Wilmington, Cal.
Zoe, Sister Mary, 1936, chem. instr., St. Mary Col., Leavenworth, Kan.

SIXTY-NINTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Kansas State College of Agriculture and Applied Science, Manhattan, Kan.
April 1 to 3, 1937

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PROGRAM

Thursday, April 1

8:00 p. m. College Auditorium.

1. Demonstration of Teaching Sound Films.
   (1) Courtesy of Gaumont British Picture Corporation, 1600 Broadway, New York City, New York. Erpi Picture Consultants. Projection machine donated and operated by A. J. Griner, Kansas City, Mo.
      a. The Amoeba.
      b. How Plants Grow.
      c. Flowers.
      d. Molecular Hypothesis.
      e. Face of Britain.
      f. The Frog.
      g. Volcanoes.
2. Moving-picture film, "How Things Grow," shown by W. J. Baumgartner.

Friday, April 2

8:30 a. m. General session. Recreation Center.
Preliminary business meeting and presentation of papers.

1:00 p. m. Demonstrations and exhibits. Anderson Hall, Room 67.
(Friday and Saturday.)

1:30 p. m. Section programs.
Botany—Dickens Hall, Room 33.
Chemistry—Waters Hall, Room 232.
Junior Academy—Manhattan Senior High School, Room 21.
Physics—Waters Hall, Room 132.
Psychology—Education Hall, Room 54.
Zoölogy—Fairchild Hall, Room 27.

6:00 p. m. Banquet. College Cafeteria. George A. Dean, Toastmaster.
Address of Welcome, F. D. Farrell, President, Kansas State College of Agriculture and Applied Science.
Presidential Address. Some Reflections on Teaching General Chemistry. Dr. Lawrence Oncley, President Kansas Academy of Science and Professor of Chemistry, Southwestern College, Winfield, Kansas.

8:00 p. m. College Auditorium.
Invitation Address under the auspices of Kansas State College of Agriculture and Applied Science with the Science Club and the Manhattan Chapter of Sigma Xi coöperating. "The History of the Bald Cypress and Redwood" by Dr. Charles F. Hottes, Head of Department of Botany and Professor of Plant Physiology, University of Illinois.

SATURDAY, APRIL 3

8:15 a. m. General Session and Business. Recreation Center, Anderson Hall.

9:00 a. m. General business meeting of the Academy. Recreation Center, Anderson Hall.

10:00 a. m. Opening Session Kansas Entomological Society, Fairchild Hall, Room 52.
Zoölogy section continued, Fairchild Hall, Room 27.
Meeting of the Nebraska and Kansas Chapters of the American Association of University Professors. Calvin Hall, Room 58.

12:00 m. *Meeting of the new executive council.* Thompson Hall.

1:30 p. m. Meeting of the Nebraska and Kansas Chapters of the American Association of University Professors. Calvin Hall, Room 58.
Kansas Entomological Society, papers. Fairchild Hall, Room 52.

PAPERS SUBMITTED FOR THE SIXTY-NINTH ANNUAL MEETING

GENERAL PAPERS

Chairman: LAWRENCE ONCLEY

Friday, April 2, 8:30 to 12:30, Recreation Center, Anderson Hall

1. Hidden Enemies: Termites. Sound Motion Picture. Lecture by Lowell Thomas. W. A. Talbott, Underhill Terminix Company, Wichita.
2. The Deterioration of Silks by Light of Different Wave Lengths. Mrs. Esther B. Nelson, K. S. C.
3. The Nutritive Value and Cost of Food Consumed at a College Residence Hall in McPherson, Kan. Esther Atkinson and Martha S. Pittman, K. S. C.
4. Rapid Method for Determination of Carotene and Flavin in milk. C. H. Whitnah, M. M. Kramer, B. L. Kunerth, K. S. C.
5. Some of the Founders and Workers of the Kansas Academy of Science. Lyman C. Wooster, Emporia.
6. Ground Cover Affects Frost Penetration. R. J. Barnett, K. S. C.
7. Recent Work on Synthetic Diamonds. J. Willard Hershey, McPherson.
8. Notable Trees of Kansas: Report for 1936. Frank U. G. Agrelius, K. S. T. C., Emporia.
9. Extent of Damage by Ice to Trees of Southeastern Kansas. H. H. Hall, K. S. T. C., Pittsburg.

GEOLOGY PAPERS

1. Notes on Some Vertebrates from the Pleistocene of Kansas. Claude W. Hibbard, U. of K.
2. An Upper Pliocene Fauna from Meade county, Kansas. Claude W. Hibbard, U. of K.
3. Glacial Striae in Kansas: Locality 19. W. H. Schoewe, U. of K.
4. Preliminary Study of the Insoluble Residues of Kansas Pennsylvanian Rocks. W. H. Schoewe, Grace Keroher, R. Keroher, U. of K.
5. Abnormal Facies of the Oread limestone formation South of Lawrence. M. K. Elias, U. of K.
6. A New Mammal-like Reptile from the Permian of South Africa. Frank Byrne, K. S. C.
7. Preliminary Notes on Pleistocene Gravels in Southwestern Kansas. H. T. U. Smith, U. of K.
8. A New Ambelodont for Kansas: a Preliminary Report. R. Mohler, McPherson College.

BOTANY SECTION

Chairman: J. H. DOELL

Friday, April 2, 1:30 to 5:30 p. m., Dickens Hall, Room 33

1. Botanical Notes for 1936. Frank U. G. Agrelius, K. S. T. C., Emporia.
2. The Myxomycetes of Kansas. Travis E. Brooks and C. L. Lefebvre, K. S. C.
3. *Sphacelotheca holci* Jackson, a New Smut on *Sorghum halepense* L. (Pers,) in North America. Earl D. Hansing and C. L. Lefebvre, K. S. C.
4. The Ecological Anatomy of *Poinsettia heterophylla.* Rufus H. Thompson, U. of K.
5. *Comandra pallida,* a Hemiparasite. Travis Brooks, K. S. C.
6. Kansas Botanical Notes, 1936. F. C. Gates, K. S. C.
7. Botanical Charts. H. H. Haymaker, K. S. C.
8. Mycological Notes. C. O. Johnston, C. L. Lefebvre, K. S. C.

9. Further Studies on *Selerotium delphinii* Welch. D. J. Obee, U. of K.
10. A New Taphrina on Cystopteris. A. J. Mix, U. of K.
11. Morphology of *Taphrina caerulescens* on Various Species of Oaks. Edna Old, U. of K.
12. The Lily-type Embryo Sac as Redescribed by Dr. D. C. Cooper. J. C. Frazier, K. S. C.
13. A Polygamous Spirogyra. Margaret Newcomb, K. S. C.
14. Cooperia in Kansas. W. C. Stevens, U. of K.
15. Ecological Anatomy of *Hymenoxys odorata*. Lucile B. Burt, U. of K.
16. Some Anatomical Features of *Amsonia tabernaemontana*. M. W. Mayberry, U. of K.
17. Anatomical observations on *Sideranthus glaberrimus* Rydb. and *S. spinulosus* (Pursh). Florene Briscoe, U. of K.
18. Succession of Plants in an Aquarium. Clinton C. McDonald, U. of Wichita.

TO BE READ BY TITLE

19. Effects of Ultra Short Radio Waves and Ultraviolet Light on Micro-organisms. L. J. Gier, Campbell College, Buies Creek, N. C.

CHEMISTRY SECTION

Chairman: L. E. Blackman

Friday, April 2, 1:30 to 3:00 p. m., Waters Hall, Room 232

1. Ten Marq Wheat as Affected by Selenium. A. T. Perkins and H. H. King, K. S. C.
2. Recent Developments in the Use of Organic Compounds as Analytical Reagents. Wayne E. White, U. of K.
3. Effect of Humidity on Specific Gravity of Soil Particles. A. T. Perkins, LeRoy Horne, H. H. King, K. S. C.
4. An Atmosphere of O_2 and N_2. J. Willard Hershey, McPherson College.
5. The Deposition of Silver in the Presence of Addition Agents. Lee Horsley and Robert Taft, U. of K.
6. Comparative Analyses of Feeding Molasses. A. T. Perkins and J. F. Merrill, K. S. C.
7. Varietal Differences in Calcium, Magnesium, Phosphorus and Nitrogen Content of Sweet Clover. E. H. Kroeker, Emil Gaeddert and Earl W. Unruh, Bethel College.
8. Observations on the Carotenoid Pigments of Some Typical Pasture Plants. F. W. Atkeson, W. J. Peterson and A. E. Aldous, K. S. C.
9. Recovery of Carotene and Vitamin A in Butter When Cows Were Fed Unlimited Quantities of Green Grass. F. W. Atkeson, J. S. Hughes, Bernice L. Kunerth, W. J. Peterson and Martha Kramer, K. S. C.
10. A New Use for p-Nitraniline Red in Developing Latent Finger Prints. Worth A. Fletcher and Ross Curtis, Univ. of Wichita.

READ BY TITLE

11. An Interpolation Table for Refractive Index-Normality Relationship for Solution of Hydrochloric Acid and Sodium Hydroxide. Allen L. Olsen, K. S. C., and E. Roger Washburn, U. of Neb., Lincoln.
12. A Study of the Reduction of Benzyl Cyanide. R. Q. Brewster and Sister Agnes Marie Horner, U. of K.
13. The Use of Xenyl Mustard Oil as a Reagent for Amines. R. Q. Brewster and Sister Agnes Marie Horner, U. of K.
14. The Action of Ethylene Dibromide Upon Disubstituted Thioureas. Ludwig Dashen and R. Q. Brewster.
15. The Biological Significance of the Phosphatases. Walter J. Peterson, K. S. C.

PHYSICS SECTION

Chairman: Louis R. Weber

Friday, April 2, 1:30 to 5:30 p. m., Waters Hall, Room 132

1. Multiple Column, Mercury Manometer. W. Cram and J. R. Roebuck, U. of Wis., Madison.
2. Radioactive Properties of the Subterranean Waters of Ellis County, Kansas. Verne Lippert, Ft. H. K. S. C., Hays.
3. A New Oscillograph. J. L. Bowman, McPherson College.
4. A Note on the Measurement of Wavelength by the Diffraction Grating. Louis R. Weber. Friends U., Wichita.
5. Photoelectric Photometer and Other Demonstration Apparatus. J. M. Schmidt, Tabor College, Hillsboro.
6. New Demonstrations of Alternating Current Phenomena. Leonard R. Crow, Educational Electric Mfg. Co., Vincennes, Ind.

7. Cosmic Rays. Wilma Hilt, K. S. C.
8. A Demonstration or a Discussion. E. V. Floyd, K. S. C.
9. The Influence of an Absorbent Lining on the Pitch of an Organ Pipe. Ernest K. Chapin, K. S. C.
10. Physical Science Courses in an Adult Educational Program. Wm. H. Matthews, K. S. T. C., Pittsburg.
11. Some Characteristics of Conductor Tie Wires. V. L. Weaver, U. of K.
12. Present Status of Neutrino Theory. R. L. Dolecek, U. of K.
13. A Simple Method of Finding the Temperature of the Carbon Arc. C. V. Kent, U. of K.
14. A Qualitative Wave Model Picture of Interaction Between Electrons in an Atom. C. V. Kent, U. of K.

PSYCHOLOGY SECTION

Chairman: Edwina A. Cowan

Friday, April 2, 1:30 to 5:30 p. m., Education Hall, Room 54

1. Relaxation as an Introduction to Rational Psychotherapy. John M. Hadley, Ft. H. K. S. C., Hays.
2. The Reliability of the Identification of the Human Voice. Frances McGehee, Wichita Child Research Laboratory, Wichita.
3. The Reliability for Placement Prediction of Developmental Testing of Infants Aged Four Months and Under. Harriet A. Branch, Friends Univ., Wichita.
4. Factors Affecting Vocational Guidance. Margaret Pankaskie, Ft. H. K. S. C., Hays.
5. Hering's Laws of Contrast Refuted by Configurational Psychology. W. H. Mikesell, Univ. of Wichita.
6. A Preliminary Study of Patterning in the Learning Curve. Alfred L. Baldwin, U. of K.
7. A Further Study of Autokinetic Movement. Albert C. Voth, U. of K.
8. An Evaluation of a Remedial Course in Study Methods for College Freshmen. W. B. Schrader, K. S. C.
9. The Function of Feeling in Adjustment. Ben F. Kimple, Kan. Wesleyan University, Salina.
10. A Concept of Gradient of Personality Integration as a Substitute for Freudian Concepts in Describing Problems of Mental Hygiene. Harry Mason, Ft. H. K. S. C., Hays.
11. The Relation of Behavior Problem Arising from Emotional Insecurity to the Degree of Change Between Home Environment. Eva Stout, Kansas Children's Home and Service League, Wichita.
12. The Cardiac Cycle as a Physiological Determinant of Energy Distributions in Speech. Martin F. Palmer, U. of Wichita.
13. Some Problems Now Confronting Clinical Psychologists in Kansas. Paul Murphy, K. S. T. C., Pittsburg.

ZOÖLOGY SECTION

Chairman: F. C. Sauer (deceased); John Breukelman, *pro tem.*

Friday, April 2, 1:30 to 5:30 p. m., Fairchild Hall, Room 27

1. Additional Distributional Records of Kansas Reptiles and Amphibians. Joe A. Tihen, U. of K.
2. The Lizards of the Southeastern United States. Charles E. Burt, Southwestern College, Winfield.
3. The Relation of the Adrenal Gland to Primary and Secondary Sex Characters in Fowls. E. H. Herrick and O. H. Torstveit, K. S. C.
4. An Anomolous Lamb. S. L. Loewen and J. Russell Jones, Sterling College.
5. The Teeth and Mandibles of Guinea Pigs Fed Different Levels of Vitamin C. Mary T. Harman, Martha M. Kramer, Homer D. Kirgis, K. S. C.
6. Notes on Some Summer Birds of Rawlins county, Kansas. Donald W. Tiemeier, U. of K.
7. Some Observations on the Ossification of the Bones of the Foot in Normal and Polydactyl Chicks. Mary T. Harman, Annette Alsop, K. S. C.
8. Drouth in Cowley county, Kansas. 1931-1936. William L. Hoyle, K. S. C.
9. The Life History and Control of the Boxelder Bug (*Leptocoris trivittatus*, Say). Roger C. Smith, K. S. C. and B. L. Shepherd, Tulsa, Okla.
10. Occurrence of Capillaria (Nematoda) in a Colony of Pigeons. George E. Cauthen, K. S. C.
11. A Study of the Habits of Reptiles and Amphibians of Ellis county, Kansas. L. A. Brennan, Andale, Kansas.
12. Some Observations on the Protozoa Fauna in Douglas county, from October, 1936 to March, 1937. Arthur E. Pullam, Jr., U. of K.
13. Segmentation of the Egg Within the Ovary and the Growth of he Graafian Follicle in the Guinea Pig. Mary T. Harman, Homer D. Kirgis, K. S. C.

14. The Weights of the Central Nervous System and of its Divisions in the Cat. H. B. Latimer, U. of K.
15. Weights and Linear Measurements of the Digestive System of the Adult Cat. H. B. Latimer, U. of K.
16. A Quantitative Study of the Skeleton of the Mourning Dove (*Zenaidura macrura carolinensis*). H. B. Latimer and C. Willett Asling, U. of K.
17. Recent Findings in the Life History of Chicken Tapeworms. W. M. Reid and J. E. Ackert, K. S. C.
18. Nutrition of the Fowl Nemotode *Ascaridia lineata* (Schneider). Alva E. Freeman, Jr. and J. E. Ackert, K. S. C.
19. Factors in the Resistance of Animals to Parasitism. J. E. Ackert, K. S. C.
20. The Reptiles af Cherokee county, Kansas. Myrna A. Hurd and H. H. Hall, K. S. T. C., Pittsburg.
21. Some Reactions of *Naegleria bistodialis* to Light Intensity Patterns. A. W. McCullough, U. of K.
22. Biological Assay of Milk With Lactoflavin as a standard for Vitamin G Determinations. Bernice L. Kunerth, Martha A. Kramer, Sister Regina Marie Dickman and C. H. Whitnah, K. S. C.
23. Vitamin A Carotene and Flavin Contents of Samples of Jersey Butter and Milk. Lester Regins, Marie Dickman, Martha M. Kramer, Bernice L. Kunerth, K. S. C.
24. Further Observations of the Results of the Feeding of Nicotine to Albino Rats. Hazel E. Branch, U. of Wichita.

ZOÖLOGY SECTION—CONTINUED

Saturday, April 3, 10:00 to 12:00 a. m.

25. New Forms of Mexican Reptiles. Edward H. Taylor, U. of K.
26. Endometrial Hyperplasia as Observed in Experimental Guinea Pigs. Olga Saffry, Mary T. Harman and Martha M. Kramer, K. S. C.
27. Some Observations Concerning the Diagnosis of the Intestinal Protozoa Parasitic to Man. Mary E. Larson, U. of K.
28. New Mexican Amphibians with Comments on Kellogg's Recent Mexican Amphibian Catalogue. E. H. Taylor, U. of K.

READ BY TITLE

29. Studies of a Small Prairie-dog Town. Theo. H. Scheffer, U. S. Biological Survey.
30. The Grasshopper Survey of Kansas in the Fall of 1936. Donald A. Wilbur, K. S. C.
31. Parasites of the Strawberry Leaf Roller, *Ancylis comptana* Froehl. (Tortricidae, Lepidoptera). S. A. Summerland, U. S. Ent., Vincennes, Ind.
32. Laboratory Manual for *Cryptobranchus alleghenicnsis*, Daubin. Hazel E. Branch, University of Wichita.
33. Further Observations in Vitamin C at Different Levels and Reproduction in Guinea Pigs. Mary T. Harman, Isabelle Gillum, K. S. C.

JUNIOR ACADEMY OF SCIENCE

Manhattan Senior High School, Room 21—Time: 1:30 p. m.

LOUIS RAYBURN—Science Club: Manhattan Senior High School, President and Presiding

BETTY COULSON—Retorts: Shawnee Mission High School, Secretary

1. Ben Franklin Club, Liberty Memorial High School, Lawrence.
   History of Petroleum Industry. Maxine Patterson.

   Demonstrations:

   Physics Section, directed by C. B. Cunningham, Sponsor.

   Chemistry Section, by Don Wetzel, Marvin Hird, Georgia Jones and Roberta Brewer. Directed by R. E. Wood, Sponsor.

   Dust Explosions.

   The Goldschmidt Process.

   Fire Water.
2. Lawrence Nature Study Club, Junior High School, Lawrence.
   My Work in Astronomy. Exhibit of Telescope and Photographs. Robert Weir. Miss Edith Beach, Sponsor.
3. Retorts, Shawnee Mission High School, Merriam.
   Demonstrations: Short-wave Radio, by Mayo McAlister and Norman Bruce. Jas. C. Hawkins, Sponsor.
4. Science Club, Manhattan Senior High School, Manhattan.
   Demonstrations: Subject and Speakers to be Announced. L. P. Elliott, Sponsor.

5. Chemistry Club, Wichita High School East, Wichita.
   Demonstrations: Subject and Speakers to be Announced. J. A. Brownlee, Sponsor.

   Induction Service for New Clubs:

   Pi Kappa Epsilon of College High School, K. S. T. C., Pittsburg. Parley W. Dennis, Sponsor.

Business

Minutes of the last meeting: Miss Betty Coulson, Secretary.

Election of officers.

Assignments for guests by Manhattan hosts.

Adjournment of the junior members.

Meeting of the judges for the honor awards.

GENERAL PAPERS AND BUSINESS

Saturday, April 3, 8:15 a. m. to 12:00 n.

1. Culture and Climatic Cycles. R. H. Wheeler, U. of K.
2. Symposium on the Geology, Flora and Fauna of Rock City, a Proposed National Monument in Ottawa County, Kansas.
   The Geology of "Rock City," W. H. Schoewe, U. of K.
   The Flora of "Rock City," W. H. Horr, U. of K.
   The Fauna—Amphibians and Reptiles of "Rock City." Charles E. Burt, Southwestern College, Winfield.
   The Fauna—Mammals and Birds of "Rock City." L. D. Wooster, Ft. H. K. S. C., Hays.
3. Coöperation Among Kansas Scientific Societies. W. J. Baumgartner, U. of K.

Business Meeting

9:00 to 10:00

10:00 a. m., Sectional Meeting

Entomology, Fairchild Hall, Room 52.

Zoölogy continued, Fairchild Hall, Room 27.

Nebraska and Kansas Chapters, American Association of University Professors. Calvin Hall, Room 58.

KANSAS ENTOMOLOGICAL SOCIETY

THIRTEENTH ANNUAL MEETING

D. A. Wilbur, President; R. L. Parker, Secretary-Treasurer

Kansas State College, April 3, 1937, Fairchild Hall, Room 52

Business Meeting at 10:00 a. m. Papers 1 to 8 at 11:00 a. m., and 9 to 24 at 1:30 p. m.

1. A Grasshopper Survey for Eastern Kansas, 1936. Laurence C. Woodruff, U. of K.
2. Orthoptera of the Prairie. Don B. Whelan, U. of Neb.
3. Differential Grasshopper Injury to Corn and Sorghums. R. H. Painter, Kan. Agr. Exp. Sta.
4. The Need of Further Research Work on the Biology and Control of Grasshoppers. George A. Dean, Kan. Agr. Exp. Sta.
5. A Curious Beetle from Australia. Milton W. Sanderson, U. of K.
6. The Genus Norvellina. Dale Lindsey, U. of K.
7. Rate of Regeneration in the Cockroach. Lois Seamans, U. of K.
8. Some Parasites of Saturniid Pupae. Louis J. Lipovsky, U. of K.
9. Notes on an Interesting Food Habit of False Wire-worm Adults. H. H. Walkden, Bur. Ent. and Plant Quar., U. S. D. A., and H. R. Bryson, Kan. Agr. Exp. Sta.
10. Attempts to Infect Termites with a Pathogenic Fungus of the Genus Empusa. C. R. Rogers, K. S. C.
11. Some aspects of the Physiological Chemistry of Insects. H. D. Thomas, U. of K.
12. Sixth Insect Population Summary of Kansas Covering the Year 1936. Roger C. Smith and E. G. Kelly, K. S. C.
13. The English Sparrow (*Passer domesticus* L.) as a Means of Transmitting Ectoparasites to Chicken Pens. Wm. L. Hoyle, K. S. C.
14. Some Leafhoppers of the Short-grass Region of the United States. Raymond H. Beamer, U. of K.

15. *The Control of the Flat-headed Borer with Paradichlorobenzene Paraffin Mixture (Chrysobothris femorata* Fab., *Buprestidae, Coleoptera). L. M.* Copenhafer, Kansas Highway Commission.
16. Two New Species of the Genus Potamobates. H. B. Hungerford, U. of K.
17. Biological Studies on Mosquitoes of the Genus Psorophora. H. H. Schwardt, K. S. C.
18. Notes on the Mosquitoes of Kansas. Miss N. A. DeMoss, K. S. C.
19. A Specimen File of Insect Injuries to Kansas Grasses. Donald A. Wilbur, Kan. Agr. Exp. Sta.
20. The Biology and Control of the Redbud Leafroller (*Gelechia cercerisella* Cham., Gelechidae, Lepidoptera). R. L. Parker, Kan. Exp. Sta.
21. The Architecture of the Generalized Insect. Philip Levereault. U. of K.
22. The Head of *Ramphocorixa acuminata* (Uhler). Melvin E. Griffith, U. of K.
23. Differential Resistence to Chinch-bug Attack in Certain Strains of Wheat. Elmer T. Jones, Bur. of Ent. and Plant Quar., U. S. D. A., Manhattan.
24. Some Notes on *Anacentrinus subnudus* (Curculionidae, Coleoptera). B. A. Osterberger and M. S. Christian, La. Agr. Exp. Sta., Baton Rouge, La.

Final Business Meeting and Election of Officers.

NEBRASKA AND KANSAS CHAPTERS AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS

Regional Meeting for Nebraska and Kansas

SATURDAY, APRIL 3, 1937

Dr. D. A. WORCESTER, Regional Chairman

10:00 to 12:15

ROBERT W. CONOVER, Kansas State College, Presiding

1. Greetings from President F. D. Farrell, Kansas State College.
2. A Teacher Looks at Teaching, Dr. Paul Murphy, Kansas State Teachers College, Pittsburg.
3. Academic Freedom. Professor John Ise, University of Kansas. Discussion Led by Professor W. H. Matthews.
4. The Relation of the Teacher to Economic and Social Problems. Dr. Trann H. Collier, Washburn College. Discussion by Professor George S. Fulbright and Professor Wallace Baldinger.

LUNCHEON—12:45, Gillette Hotel

KINGSLEY GIVEN, Presiding

Welcome by Dr. S. A. Nock, Vice-president, Kansas State College.

The Economic Status of the College Teacher, Arthur Peine.

SECOND SESSION

3:00 p. m., Calvin Hall, Room 58

Dean C. M. CORRELL, Presiding

5. The Length of the Teaching Year, and Provisions for Sabbatical Leave at Teachers Colleges, Professor H. E. Schrammel, Kansas State Teachers College, Emporia.
6. The Faculties of Publicly Maintained Colleges and Universities. Professor E. H. Hollands, University of Kansas.
7. Effective Organization of the Local Chapter. Dr. D. A. Worcester, University of Nebraska.

RECEPTION and TEA, Calvin Hall, 4:15 p. m.

MINUTES OF THE SIXTY-NINTH MEETING OF THE KANSAS ACADEMY OF SCIENCE

Manhattan, Kan., April 1, 2 and 3, 1937

The meeting was opened Thursday evening, April 1, with a demonstration of some late teaching sound films and the showing of a silent film by Dr. W. J. Baumgartner on "How Things Grow."

The first general meeting occurred on Friday Morning, April 2, with President Oncley in the chair, at which time a group of papers of general interest were presented. These were followed by the papers on geology, which were grouped together and given at the general session Friday morning, since the geologists had planned a field trip for Friday afternoon, under the leadership of Prof. Arthur Sperry, to see an important igneous outcrop near Riley and other features of Northwestern Riley county. Thirty-five made the field trip.

On Friday and Saturday afternoons, the Academy met in sectional meetings. The attendance at all the meetings was as follows:

Thursday evening lecture, films	800
Friday morning, general meeting	250
Saturday morning, general meeting	200
Botany section	45
Chemistry section	50
Physics section	97
Psychology section	50
Zoölogy section	65
Junior Academy of Science	100
Kansas Entomological Society	70
Nebraska and Kansas Chapter, American Association of University Professors	80

The registration at the Academy registration desk totaled 307. The registration at the Kansas Entomological Society totaled 72, while at the University professors' meeting the registration was 52. The total attendance, eliminating duplicate registrations, was 411.

The chairman appointed the following members to serve on the committee on resolutions: J. Ralph Wells, chairman, E. O Deere and John M. Michener.

The following sectional chairmen were elected at the close of sectional meetings.

Botany: Margaret Newcomb, K. S. C., Manhattan.
Chemistry: Lloyd McKinley, Univ. of Wichita, Wichita.
Entomology: Warren Knaus, McPherson.
Physics: C. V. Kent, University of Kansas, Lawrence.
Psychology: O. W. Alm, K. S. C., Manhattan.
Zoölogy: Claude Hibbard, U. of K., Lawrence.
Junior Academy: Oscar Klingman, Junction City.

At the Saturday business meeting the following amendments were passed:

"SEC. 4. The officers of this academy shall be chosen by ballot at the annual meeting and shall consist of a president, a *president elect,* a vice-president, a secretary, etc."

"SEC. 7. This academy shall have an executive council, consisting of a president, the secretary, the treasurer, *the president-elect,* the vice-president, the

retiring president, the editor, *managing editor, and three other members to be nominated by the nominating committee,* and elected as the other officers."

By-law XIII. In selecting papers for publication in the TRANSACTIONS of the Kansas Academy of Science, the editor or editorial board shall refuse papers by nonmembers, or by members who are in arrears."

It was voted to restrict the privilege of having titles listed on the program of the meetings, of presenting papers at the meetings as well as for their publication, to members of the Academy who have their dues and other obligations paid. This has been the practice, but the motion was made so that a minute could be included in the report of the meeting.

It was voted to continue the small charge made of authors who publish papers in the TRANSACTIONS, but to clarify to each that the charge was made to aid in meeting the expense incurred in the publication of the papers, such as trips of the managing editor to Topeka, correspondence of the secretary and editor in regard to the paper, postage on the papers, galley proofs, and reprints and other expenses. There is no charge for the actual reprints.

It was voted to instruct the secretary to investigate trading off the old paste-ink addressograph, which is nearly worn out, and to buy a new one if a satisfactory purchase could be made.

The bequest tendered the Academy by Mrs. Otilla Reagan, wife of the late Dr. Albert B. Reagan, was accepted gratefully by the Academy, as was also the following regulations in handling the endowment:

PLANS FOR THE ADMINISTRATION OF THE ALBERT B. REAGAN ENDOWMENT TO THE KANSAS ACADEMY OF SCIENCE

1. This endowment shall be known as the Albert B. Reagan endowment fund.
2. The custody of the Albert B. Reagan endowment fund shall be assigned to the committee on investments and endowments of the Kansas Academy of Science.
3. The funds constituting the principal of this endowment shall not be spent, but kept invested in some safe manner as determined by the committee on investments. The income from this endowment shall be awarded by the committee on awards to one or more members in good standing in the Kansas Academy of Science who make application for it, for aiding in the publication or preparation of papers for publication. The awards, which shall be numbered consecutively and referred to by number, shall be made annually if deserving and meritorous applications for them are filed, but the funds may be held over for as many as three years if in the opinion of the committee no award should be made, or added to the principal of the endowment. The award shall be made on the basis of need and greatest possibilities of accomplishment to persons in any field of science represented by the Academy, but in cases of equal merit preference shall be given to contributions in the fields of archeology and anthropology in honor of the donor of the endowment.
4. Mrs. Otilla Reagan shall be informed of the awards each year, and all matters related to this endowment shall be recorded in the printed records of Academy business.
5. The purposes for which this endowment shall be administered may be changed only by permission of Mrs. Reagan if living, by three fourths vote of the executive council and a three fourths vote of those members in good standing at the business meeting of one of the regular meetings.
6. All research work to which a grant from this fund has been made shall be published in the TRANSACTIONS of the Kansas Academy of Science and bear an acknowledgement of this assistance, indicating the number and amount of the grant.

7. Mrs. Otilla Reagan shall be made a life member of the Kansas Academy of Science in recognition of her interest in science and her coöperation in establishing this endowment in the Kansas Academy of Science.
8. The endowment of April 1, 1937, consists of one $1,000 United States treasury coupon bond, 3¼ percent, 1943-'45, No. 233,473 C, dated October 15, 1933. The coupons are payable April 15 and October 15, and each are for $16.25. The first coupon falls due April 15, 1937.

Mrs. Otilla Reagan was introduced both at the banquet and business meeting, at which time she responded briefly with touching comments of Doctor Reagan. She had copies of the last two publications of Doctor Reagan, most of which were sold to members of the Academy.

Mrs. Otilla Reagan, Dr. J. R. Wells and Prof. George A. Dean were elected life members of the Academy on the conditions specified in the constitution, section 3, article 2.

Membership cards were distributed to the 104 new members joining since the last meeting.

It was decided that the Academy should accept the invitations to meet at the Kansas State Teachers College at Pittsburg in the spring of 1938 and at the University of Kansas in 1939.

It was voted to augment the $25 given to the Academy for research awards by the A. A. A. S. by $25, and to award $100, as had been done in 1936. An effort will be made to make these awards before June 1, 1937, to assist the workers most effectively.

The reports of the various committees and officers were presented, and all adopted. After the report of the nominating committee the secretary cast a unanimous ballot for the officers nominated, and they were declared elected. Retiring President Oncley called President Dean to the chair, who responded with appropriate remarks and conducted the remainder of the meeting.

The meeting adjourned.

ROGER C. SMITH, *Secretary.*

April 5, 1937.

LAWRENCE ONCLEY, *President.*

REPORT OF THE SECRETARY, 1936-1937

The minutes of the sixty-eighth meeting have been prepared and are printed in volume 39 of the TRANSACTIONS.

Volume 38 was distributed to all paid-up members and to coöperating libraries on May 8, 1936. A total of 1,117 copies were accounted for, leaving none in the secretary's office for future sale. However, the coöperating libraries returned some of their allotment to complete the mailing list and leave a few copies on hand.

Cards were sent to the seventy-one legislators, and forty-six asked to have a copy of the TRANSACTIONS sent. However, only forty could be sent because of the small number available.

Prof. George A. Dean, first vice-president, served most capably as acting secretary from June 1 to January 15, during the seceretary's absence on an extended trip.

Notices of the research award from the A. A. A. S. and invitations to apply were sent to the entire membership on September 1, 1936. Applications were sent directly to the chairman of the research award committee, whose report and action are given elsewhere. The research fund was increased by $25 from the Academy treasury, making a total of $100 awarded.

Dr. F. C. Sauer, who was elected chairman of the zoölogy section, died April 18, 1936, and Dr. John Breukelman was elected chairman *pro tem* by the executive committee. Other deaths in the Academy membership which were reported to the secretary were of Dr. J. McWharf and Dr. Edward C. Franklin.

In early May the secretary sent a second notice to those delinquent in 1936 dues, with little response.

The secretary designed and had 500 membership cards printed at the suggestion of the executive committee. There is a strong desire among officials of the Academy to make membership in the Academy more significant. Granting a signed card following their election is one suggestion toward this end.

A new dues card was designed this year and the dues were sent directly to the treasurer. This new card and plan has worked out admirably to all concerned.

Notices concerning the sixty-ninth meeting of the Academy were mailed out February 1. The response was rather slow, particularly in psychology and chemistry. Finally, however, the present excellent program was arranged. Members of the Academy forget each year that only members with their current dues and other obligations paid may give papers at the meetings and have them printed in the TRANSACTIONS. This is especially overlooked in the case of graduate students and joint authors of papers. There is always such a rush at the time of making up the program that there is not time to wait for replies to the notice sent out by the secretary. As a result, every year there are nonmembers included in the program. This matter can be checked upon before publication, however, but even then once in awhile one slips through. The members could greatly assist the secretary and editor if they would read the directions for sending in titles and follow this requirement. Students who do not wish to join the Academy should not be listed as authors, but acknowledgment made them in a footnote.

The secretary discovered that stencils had not been made for all of last year's members. The stencils are being carefully checked and all omissions will be corrected soon.

Miss Maurine Haley, an N. Y. A. employee, has served very capably as stenographic assistant to the secretary during the school year. She has given approximately eleven hours a week to the Academy.

The American Association of University Professors, Kansas and Nebraska chapters, are holding their meeting in coöperation with the Academy this year. Their sessions are open to all and it is hoped that the Academy will be well represented at the reception and tea, at 4:15 Saturday.

REPORT ON ACADEMY MEMBERSHIP, APRIL 3, 1937

On March 31, 1937, the membership of the Academy was as follows:

Annual members	476
Life members	49
Honorary members	10
Junior Academy clubs	6
Grand total membership	541
Former members reinstated	2
New members April 1, 1936 to April 3, 1937	104
New Junior Academy clubs	1
Total gain by new members	107

Members to be dropped for nonpayment of dues	70
Members resigned	1
Members deceased	2
Total loss in membership	73
Number of annual members with 1937 dues paid (not including the 104 new members)	233
Number whose 1936 dues are unpaid	70
Number whose 1937 dues are unpaid	145

The Academy is in excellent condition. The officers have all worked faithfully and there is a splendid interest on the part of the membership in the Academy.

ROGER C. SMITH, *Secretary.*

REPORT OF MEMBERSHIP COMMITTEE

NEW MEMBERS

From April 1, 1936, to April 1, 1937

Name.	*Interest.*	*Recommended by*
Aldous, A. E.	Agronomy	J. H. Parker
Alsop, Annette	Zoölogy, Ecology, Embryology	Mary T. Harman
Allsbury, Carl	Zoölogy	Frank Agrelius
Ameel, Donald J.	Zoölogy	M. J. Harbaugh
Atkeson, F. W.	Biology	Roger C. Smith
Ayers, John C.	Zoölogy	Roger C. Smith
Bayles, Ernest E.	Psychology	Bert A. Nash
Beamer, R. H.	Entomology	Roger C. Smith
Bergstresser, Karl S.	Chemistry	W. B. Wilson
Bernhart, Arthur	Physics	W. B. Wilson
Borman, Ina M.	General	J. P. Drake
Brickey, Harold	Chemistry	Frank Agrelius
Bridwell, Arthur	Geology	Walter Schoewe
Brooks, Travis E.	Botany	C. L. Lefebvre
Brown, Edwin J.	Psychology	F. U. G. Agrelius
Bryan, Aldro	Chemistry	L. E. Blackman
Bugbee, Robert E.	Zoölogy	D. E. Schaffner
Burford, Wesley R.	Chemistry	H. A. Zinszer
Burt, Lucile	Botany	W. C. Stevens
Byrne, Frank	Paleontology	R. C. Smith
Cauthen, Geo. E.	Zoölogy	R. C. Smith
Chidester, Leona	Biology	G. A. Dean
Clark, J. Tate	Geology	W. H. Schoewe
Cohilta, Raymond E.	Geology	W. H. Schoewe
Coleman, Hubert P.	Geology	W. H. Schoewe
Conn. State College Library		R. C. Smith
Cram, S. Winston	Physics	L. E. Blackman
Cunningham, Arleigh	Biology	F. U. G. Agrelius
Dashen, Ludwig	Chemistry, Physics	R. Q. Brewster
Dennis, Parley W.		J. Ralph Wells
Elwell, Leonard H.	Zoölogy	R. K. Nabours
Fletcher, Hazel M.	Physics	Martha Kramer
Fuller, Glen	Botany	J. H. Doell
Gladfelter, C. A.	Botany	J. Breukelman
Goff, Richard	Zoölogy	J. Breukelman
Good, Newell E.	Entomology	R. C. Smith
Groody, H. T.	Zoölogy	R. C. Smith
Hadley, John M.	Psychology	Geo. A. Kelly
Hansing, Earl D.	Botany	C. L. Lefebvre
Hawkins, Paul	Biology	W. J. Baumgartner
Haymaker, H. H.	Botany	H. A. Zinszer

REPORT OF MEMBERSHIP COMMITTEE—Continued

New Members

From April 1, 1936, to April 1, 1937

Name.	*Interest.*	*Recommended by—*
Hermanson, Joe L.	Chemistry	E. O. Deere
Hilton, Willard O.	Geology	W. H. Schoewe
Hopkins, J. Frank	Biology	J. Ralph Wells
Horner, Sister Agnes	Chemistry	H. A. Zinszer
Hurd, Myron A.	Zoölogy and Ecology	H. H. Hall
Jones, J. Russell	*Zoölogy*	S. L. Loewen
Keroher, Raymond	*Geology and Entomology*	*W. H. Schoewe*
Keroher, Grace	Geology and Entomology	W. H. Schoewe
Kirgis, Homer D.	Embryology	H. A. Zinszer
Kleihege, J. B.	Geology	W. H. Schoewe
Knowlton, Reginald		M. J. Harbaugh
Lane, Charles E.	Zoölogy	Hazel E. Branch
Lockard, Gene K.	Zoölogy	F. U. G. Agrelius
Long, Sam	Chemistry	Ralph Bogart
McLaughlin, Thad G.	Geology	W. H. Schoewe
Merchant, Frank E.	Geology	W. H. Schoewe
Merrill, Joseph F.	Chemistry	A. T. Perkins
Michaelson, Louis	Chemistry	John Michener
Myers, Robert	Zoölogy	J. Breukelman
Nelson, Esther B.	Chemistry	H. A. Zinszer
Newell, N. D.	Geology	W. H. Schoewe
Olsen, Allen L.	Physical Chemistry	R. C. Smith
Pady, Stewart A.	Botany	W. B. Wilson
Peterson, Oscar J.	Physics	Frank Agrelius
Peterson, Walter J.	Chemistry	J. S. Hughes
Pinner, Bert		Mary Harman
Plum, W. B.	Physics	L. Oncley
Ponder, Luke H.	Zoölogy	W. J. Baumgartner
Puffinbarger, J. P.	Psychology	B. A. Nash
Reagan, Otilla (Life Member)		R. C. Smith
Rizzo, Nicholas D.	Psychology	B. A. Nash
Rolfs, Marvin E.	Physics	Ward Witherspoon
Ruff, Charles E.	Zoölogy	J. R. Wells
Saffrey, Olga B.	Zoölogy, Foods and Nutrition	Mary T. Harman
Schellenberg, P. E.	Psychology	S. L. Leowen
Schrader, William B.	Psychology	J. C. Peterson
Schultis, W. J.	Physics	J. L. Bowman
Schwartz, J. D.	Chemistry	Ward Witherspoon
Schultz, P. D.	Chemistry	H. E. Crow
Shaffer, H. Lloyd	Geology	W. H. Schoewe
Shepherd, B. L.	Entomology and Zoölogy	R. C. Smith
Smith, Charles Lewis	Veterinary Medicine	F. U. G. Agrelius
Smith, H. T. U.	Geology	W. H. Schoewe
Smith, V. T.	Geology	W. H. Schoewe
Stephens, Homer A.	Zoölogy	———
Stout, Eva		Edwina Cowan
Summerland, S. A.	Entomology	R. C. Smith
Swain, Fred M.	Geology	W. H. Schoewe
Terry, Lyman	Geology	W. H. Schoewe
Thomsen, Lillian C.	Entomology	E. O. Deere
Tiemeier, Otto W.	Zoölogy	W. J. Baumgartner
Travis, Gerald	Zoölogy	H. H. Hall
Unruh, Earl W.	Chemistry	E. H. Kroeker
Van Wormer, Fay	Geology	J. F. Sternberg
Varvel, Walter A.	Psychology	Bert Nash
Walters, Phillip	Geology	A. B. Sperry
Washburn, E. Roger	Chemistry	Allen E. Olsen

REPORT OF MEMBERSHIP COMMITTEE—Concluded

New Members

From April 1 1936, to April 1, 1937

Name.	*Interest.*	*Recommended by—*
Weber, A. D	Zoölogy	Mary Harman
Weber, Wallace	Physics	J. P. Drake
Whelan, Don. B	Entomology	R. C. Smith
White, Wayne E	Chemistry	Robt. Taft
Williams, John R	Biology	Frank Agrelius
Wong, Wai-Sing	Animal Genetics	Herman Ibsen

Total, 105.

Renewals

From April 1, 1936, to April 1, 1937

Name.	*Interest.*
Cory, William L	Medicine
Elias, M. K	Geology
Haymaker, H. H	Botany
Schmidt, J. M	———
Stogsdill, J. W. E	Physics

Total, 5.

REPORT OF TREASURER

April 2, 1936 to April 1, 1937

Receipts

Balance on hand April 2, 1936	$49.36
Dues from members	383.00
Reprints to members	74.14
Sale of Transactions	7.15
Exchange rights, vol. 38, Kansas State College	200.00
Interest on endowment fund	32.53
A. A. A. S. award	75.00
Principal and interest on postal savings certificates	407.00
Appropriation by Kansas legislature	300.00
Total	$1,528.18

Disbursements

Kimball Printing Co., printing		$43.00
Capper Engraving Co., cuts for vol. 39		300.00
Emporia meeting, expenses		32.71
Junior Academy, expenses		11.16
Managing editor, Topeka		8.00
Editor in chief, St. Louis, postage		26.25
Treasurer, metal cabinet, postage		29.25
Secretary:		
Stationery and postage		23.19
Secretarial help		37.29
Expressage of Transactions		5.56
J. P. Puffinbarger, A. A. A. S. and Academy award		50.00
S. L. Loewen, A. A. A. S. award		50.00
One $500 U. S. savings bond D138039B		375.00
Three $100 U. S. savings bonds C492889B to 91B		225.00
Two $100 postal savings certificates G594048 and 56		200.00
Balance on checking account		111.77
Total		$1,528.18
Supplementary statement:		
Bank balance	$251.02	
Postal savings certificates	500.00	
Total		$751.02
Uncanceled checks	$139.25	
Payable to endowment fund	65.43	
Total		$204.68
Net balance		$546.34

Note.—Payments on exchange rights for the 1936 Transactions, volume 39, have not been received. The volume in question is still in press.

Respectfully submitted,

Harvey A. Zinszer, *Treasurer.*

''T OF ENDOWMENT COMMITTEE

RECEIPTS

Balance in general fund	$32.90
Earnings during 1936	32.53
Transferred from general fund	600.00
Total	$665.43

DISBURSEMENTS

One $500 U. S. savings bond D138039B	$375.00
Three $100 U. S. savings bonds C492889B to 91B	225.00
In general fund	65.43
Total	$665.43

INVESTMENTS

4 shares (620 to 623) Morris Plan, Wichita 5 percent	*$400.00*
5 shares (OS-1181) First Federal Savings and Loan of Kansas City, $94.53 at 4 percent; Cert. 1269 Western Shares, Inc., of Kansas City, $205.47	*300.00*
1.5 shares (2398 full-paid) Greene Co. B. & L. 4 percent	150.00
1.5 shares (2679 Class B) Greene Co. B. & L.	150.00
1 (11859K) U. S. treasury bond 1951-55 at 3 percent	100.00
1 (670L) U. S. treasury bond 1951-55 at 3 percent	50.00
1 (L235510, formerly L108609 and L394570) $50 U. S. savings bond 1945	37.50
1 (C260992, formerly C418739 and C446475) $100 U. S. savings bond 1945	75.00
1 (D84554, formerly D74388) $500 U. S. savings bond 1945	375.00
1 (C446471, formerly C446461) $100 U. S. savings bond 1945	75.00
1 (C446472, formerly C446462) $100 U. S. savings bond 1945	75.00
1 (D138039B) $500 U. S. savings bond 1946	375.00
1 (C492889B) $100 U. S. savings bond 1946	75.00
1 (C492890B) $100 U. S. savings bond 1946	75.00
1 (C492891B) $100 U. S. savings bond 1946	75.00
In general fund	65.43
Total	$2,452.93

This year the Greene County Building and Loan Association of Springfield, Mo., was reorganized, whereby 50 percent of each share of old stock was federalized to bear 4 percent interest; the remaining 50 percent was rewritten as noninterest bearing stock until such time as the company's assets warrant a change.

Respectfully submitted,

ZINSZER, GRIMES, DAVIDSON AND ALBRIGHT,

REPORT OF AUDITING COMMITTEE

We have carefully gone over the accounts and also examined the certificates and bonds of investment and find them to be correct.

However, it is the judgment of your committee that the investments, although nontransferable, should be held in a lock-box of a bank, to which the treasurer and at least one other member of the Academy should have access. Also, the treasurer should be bonded at the expense of the Academy, for the sum of at least $1,000.

W. G. WARNOCK.
MARGARET H. HAGGART.

REPORT OF THE DELEGATE TO THE CONFERENCE OF THE STATE ACADEMIES AT ATLANTIC CITY, DECEMBER 28, 1936

The delegate wrote a short history of our Academy and its doings. O. W. Caldwell, the permanent secretary of the A. A. A. S., liked the report so well that he asked permission to publish it in *Science*. The proof was read and returned to Doctor Cattell late in February, and it will no doubt appear soon.

From the reports given at Atlantic City the national office did not have the *problems of research* of the awardees of our Academy. These titles were

later sent in. Our committee on awards should report details to the general secretary, O. W. Caldwell, Boyce-Thompson Institute, Yonkers, N. Y.

Academies were urged to supplement the research awards from their own funds wherever possible.

Academies were urged to study and work out the best plan of selecting the awardees and are asked to report such plans to the national association, which hopes later to publish the best ones evolved. Indiana's plan was highly commended.

All academies were asked to push the junior academies. One idea presented which we might adopt is to hold the meeting on Saturday morning, so as not to interfere with Friday's school work.

All three delegates of the A. A. A. S., Doctors Ward, Caldwell and Cattell, agreed that the best work the national association was engaged in during the present years was the encouragement of and the building up of the state academies of science. The secretaries seemed pleased with the responses of the academies.

Some special features reported were: (1) Field trips, geological and also biological; (2) promotion of science talks by radio; (3) publication of science leaflets for the junior academies.

The twenty-seventh State Academy, Florida, was welcomed as the "baby" academy.

W. J. BAUMGARTNER,
Delegate of the Kansas Academy of Science.

COMMITTEE ON NATURAL AREAS AND ECOLOGY

MANHATTAN MEETING, APRIL 1 TO 3, 1937

1. The committee concentrated chiefly on its national-monument project. W. H. Schoewe investigated the geology of "Rock City," the site of the proposed national monument near Minneapolis, Kan., and prepared several maps of the same. W. H. Horr visited the site several times and made observations on the flora, whereas C. E. Burt and L. D. Wooster studied the fauna. A report was sent to the director of the National Park Service, who assured the committee that our project would be investigated. Letters, including the report sent to the Park Service, were sent to each of the United States senators and representatives from Kansas at Washington, urging them to do all they could to further the cause by which "Rock City" may be made a national monument.

2. Further steps to carry out the project on labeling of trees and shrubs are under way. The chairman has been assured of coöperation in the project by the president of the Kansas Association of Garden Clubs. Over 500 trees and shrubs were labeled at Pittsburg and vicinity under the supervision of Prof. H. H. Hall.

3. The committee on coöperation with the Kansas Geological Survey distributed to all of the Academy members a booklet entitled "Scenic Kansas," prepared by Dr. K. K. Landes, of the Kansas Geological Survey.

4. C. Hibbard represented the committee at the American Wild Life Conference held at St. Louis in February.

5. The chairman of the committee wrote to Mr. Hans, state fish and game

warden of Kansas, suggesting an educational function for our state parks in addition to those for recreation and fishing purposes, for which our parks are now chiefly used. The services of members of the Academy were offered for labeling trees, shrubs, rock formations, without cost to the State Fish and Game Commission, except for traveling expenses.

6. Prof. W. A. Matthews supervised improvements in the Crawford County State Park and studied the waters in the ponds for acidity for purposes of stocking them with fish.

The committee wishes to recommend the following:

1. Change name of our committee to Committee on Conservation and Ecology.

2. Request $75 for the work of our committee for the coming year.

3. Contribute $5 to the American Ecological Society for their work.

4. Academy go on record as being opposed to the construction of an irrigation tunnel through the Rocky Mountain National Park. And that the Committee on Natural Areas and Ecology be ready to help kill the bill or any other attempts to commercialize our national parks and monuments.

5. Ask for a continuation of the same personnel of our committee, with perhaps an additional member or two. Our national-monument project is now in the hands of the director of the United States National Park Service and the Kansas senators and representatives at Washington. I believe we should not change the committee until the project started is settled one way or the other.

H. H. Hall. W. A. Matthews.
C. Hibbard. L. D. Wooster.
W. H. Horr. W. H. Schoewe, *Chairman.*
C. E. Burt.

JUNIOR ACADEMY OF SCIENCE

Hazel E. Branch, University of Wichita, Wichita, *Chairman*

Report of the Junior Academy Committee. The Junior Academy Committee was enlarged in 1936 to include teachers of science from each of the congressional districts of the state. Inquiries were made of the principals of the high schools of key cities, for the names of teachers who might be interested. From these names and the sponsors of affiliated clubs, a committee of sixteen was selected:

Physical Sciences. J. A. Brownlee, Wichita; H. R. Callahan, Junction City; C. H. Dresher, McPherson; L. P. Elliott, Manhattan; Jas. C. Hawkins, Merriam; Robert E. Wood, Lawrence.

Biological Sciences. Miss Edith Beach, Lawrence; L. W. Cooley, Arkansas City; Harry J. Dodd, Great Bend; Robert Myers, Coffeyville; Frank Prentup, Beloit; Ralph J. Wells, Pittsburg; Fred Williams, Onaga.

General Science. Dewey Bennett, Garden City; R. L. Tweedy, Hays; Robert Ward, Garden City.

Each of the committee was consulted and found willing to appear before the science round tables of the Kansas association in November. The chairman received permission from each of the science groups to use five to ten minutes of program time to explain the work of the Junior Academy and to

obtain the names of the teachers interested. The members of the committee were furnished with literature and general suggestions for their presentations, and thirteen of the fourteen round tables were addressed.

The names of interested teachers were forwarded to the chairman, and follow-up letters and literature, as well as affiliation blanks, were sent to them, and also to all committeemen, round-table chairmen and principals who had responded to inquiries.

We have seven affiliated clubs: Lawrence Nature-study Club, Lawrence junior high school, Lawrence; Retorts, Shawnee-Mission high school, Merriam; Ben Franklin Club, Liberty Memorial high school, Lawrence; Chemistry Club, Wichita high school east, Wichita; Phi Kappa Epsilon, College high school, Pittsburg (new this year); Science Club, Manhattan senior high school, Manhattan; Science Club, Junction City senior-junior high school, Junction City.

The sixth annual meeting of the Junior Academy of Science was held in room 21, Manhattan senior high school, at 1:30 p. m. April 2, 1937. There were 115 students and 15 adults present. A delegation of 18 students from Madison high school, sponsored by E. L. Kirkpatrick, visited the meeting, and the Junction City Club sent 25 members to the meeting. President Oncley and Secretary Smith visited the meeting and Doctor Oncley inducted the new member club from Pittsburg, with Parley Dennis, sponsor.

The meeting was called to order and presided over by Louis Raburn, of Manhattan senior high school. In the absence of Miss Betty Coulson, of Shawnee-Mission high school, Miss Georgia Jones acted as secretary.

The program proceeded as printed in the announcement, with the exception of the omission of the demonstrations by the Retorts from Shawnee Mission, due to absence, and the addition of demonstrations by the Science Club of Junction City high school, sponsored by H. R. Callahan.

At the business meeting following the program, Oscar Klingman, of Junction City, was elected president and Georgia Jones, of Liberty Memorial high school, Lawrence, was elected secretary.

C. H. Dresher, McPherson, Parley Dennis, Pittsburg, and J. Ralph Wells, Pittsburg, judged the presentations of the program for the honor awards. The following announcement was made at the Friday evening session of the Academy:

Papers: First place, Robert Weir, Lawrence Nature Study Club, "My work in Astronomy"; honorable mention, Kathryn Blevins, Science Club, Manhattan, "A New Frontier for America."

Demonstrations: First place, Chemistry Club of Wichita high school east; honorable mention, Ben Franklin Club, Lawrence.

A letter complimenting Kansas upon her Junior Academy was received from Dr. Otis W. Caldwell, of the A. A. A. S., April 3, 1937.

Respectfully submitted, HAZEL E. BRANCH, *Chairman.*

REPORT OF THE COMMITTEE ON THE COORDINATION OF SCIENTIFIC GROUPS

APRIL 1, 1937

The committee reports progress and recommends:

That the committee, as such, be continued, and

That the committee be authorized to organize the various groups of scientists in Kansas by forming an advisory council made up of two representatives from each scientific group wishing to be represented;

That this committee be empowered to appoint the two representatives from the Kansas Academy to such a council.

W. G. WARNOCK, Hays,
J. B. STROUD,
Kansas State Teachers College, Emporia.
BERNICE L. KUNERTH,
Kansas State College, Manhattan.
JOHN M. JEWETT,
University of Wichita, Wichita.
W. J. BAUMGARTNER,
University of Kansas, Lawrence, *Chairman.*

REPORT OF COMMITTEE ON NECROLOGY

The Committee on Necrology submits the following biographies.

ALBERT B. REAGAN—1871-1936

Albert B. Reagan, a member of the Kansas Academy of Science since 1904, was born near Maxwell, Iowa, on January 22, 1871, and died at Provo, Utah, May 30, 1936. He was the son of William Simpson and Annie Emily Reagan. His early life was spent in Iowa. At the age of sixteen he removed with his parents to a point near Fredonia, Kan. Returning to his native state at the age of nineteen, he began teaching school.

He began his college education at Central Teachers' College, in Oklahoma, where he was graduated in 1898. The next year he entered the Indian Service in New Mexico. However, he continued his education, taking the degree of bachelor of science at Valparaiso University in 1902. He received the bachelor of arts degree from the University of Indiana the same year, and the master of arts degree in 1903. The doctor of philosophy degree was conferred on him in 1925 by Leland Stanford, Jr., University.

Doctor Reagan's thirty years of work in the Indian service took him into New Mexico, Arizona, South Dakota, Washington, Minnesota, Colorado and Utah. This gave him the opportunity to carry out a vast amount of research in a variety of fields. He was a prolific writer, having published more than five hundred titles. These included papers on botany, anthropology, archaeology, astronomy, meteorology, geology and ethnology. The TRANSACTIONS of the Academy contain more than fifty of his reports. At the time of his death Doctor Reagan was special professor of anthropology, Brigham Young University, Provo, Utah. He was a fellow in the American Association for the Advancement of Science and held membership in a large number of other learned societies.

On June 15, 1903, Doctor Reagan was united in marriage to Miss Otilla Adelaide Reese, who survives him. Other living relatives are two brothers, Herman C. and George W. Reagan, and two sisters, Mrs. C. A. Bates and Mrs. Rhoda Hurley.

George Carl Shaad—1878-1936

George Carl Shaad was born in Stratford, N. Y., on May 5, 1878, the son of George and Christina (Ernst) Shaad. He obtained the degree of B.S. in electrical engineering from the Pennsylvania State College in 1900 and that

GEORGE CARL SHAAD

of electrical engineer in 1905. He married Merthyr Tydvil Evans, of West Pittsdon, Pa., September 1, 1906. His widow and four children, Dorothy, Paul, George Ernst and David, survive him.

After graduation in 1900 he worked for two years for the General Electric Company, of Schenectady, N. Y. In the fall of 1902 he went to the University of Wisconsin as instructor, and was advanced to assistant professor in 1904. In 1906 he went to Massachusetts Institute of Techology as an assistant professor and was later advanced to associate professor.

In 1909 he came to the University of Kansas as head of the department of electrical engineering. During the war period, in 1917-'18, he became acting dean during the absence of Dean P. F. Walker. After Dean Walker's death in 1927 Professor Shaad was immediately chosen as dean of the School of Engineering and Architecture.

Dean Shaad wrote for the professional press. His book on "The Construction and Operation of Electrical Power Stations" was published as a section of the Standard Handbook for Electrical Engineers.

He was a member of such professional and honorary societies as the American Institute of Electrical Engineers, American Society of Mechanical Engineers, International Engineering Society, Sigma Xi, Tau Beta Pi, and Phi Kappa Phi. He was a fellow in the American Institute of Electrical Engineers, formerly vice-president for the southwest district, and at the time of his death a member of its board of directors. Shortly before his death he was appointed a member of the delegatory committee of the Engineers' Council for Professional Development to represent the American Institute of Electrical Engineering for the states of Kansas, Missouri, Arkansas, Oklahoma, Louisiana and eastern Texas.

In the latter part of June, 1936, Dean and Mrs. Shaad and son, David, set out in their car to attend the annual convention of the American Institute of Electrical Engineers at Pasadena, Cal. On the way Dean Shaad contracted a severe intestinal ailment. On arriving at Pasadena he went to the Huntington Memorial Hospital, where his death occurred on July 9th.

Thus, briefly, we mark the passing of a noted engineer, a successful educator, and man of marked administrative ability. Others will take up his work and carry on, but to a certain extent the place he occupied in the engineering and educational field cannot be filled.

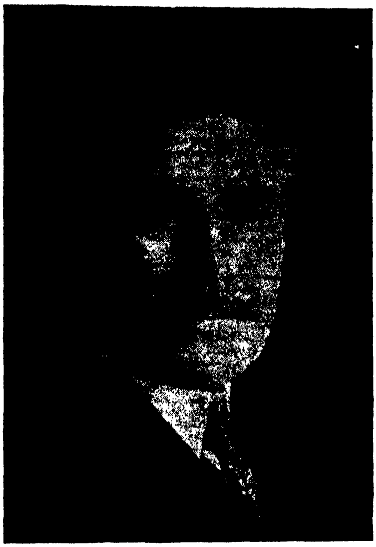
Edward Curtis Franklin—1862-1937

Dr. Edward Curtis Franklin, professor emeritus at Leland Stanford, Jr., University, died February 13, 1937. He was born on a farm near Geary City, Kan., on March 1, 1862, the eldest son of Thomas Henry and Cynthia Ann (Curtis) Franklin. His father operated a sawmill in the bottoms of the Missouri river and Edward spent his boyhood as any normal boy would do in such an environment. He early acquired the roving habit, which persisted to the time of his death. He was fond of swimming, trapping and fishing. At the same time he became a keen observer of nature and collected many geological specimens from the river bluffs. Before Edward was fifteen he and his younger brother, Will, had built a telegraph line two miles long and they became quite expert in the use of the Morse code. The year after Alexander Graham Bell first exhibited his newly invented telephone at the Centennial Exposition of 1876, the two boys, with the assistance of their father, constructed two telephones and connected the house with the sawmill.

At the age of twenty-two Franklin entered the University of Kansas. He was graduated in due time and two years later he and Will went to Europe to travel and study. Edward spent a year in Berlin. Returning to Kansas, he taught chemistry two years in the University, then went to Johns Hopkins to study with Professor Remsen. He was awarded the doctorate here in 1894. Again he returned to Kansas, this time as an associate professor in the University. Two years later he resolved to try his hand in the industrial world and became chemist and manager of a gold mine and mill in Costa Rica. One year of this was sufficient, and he came back to his alma mater as a professor

of chemistry. He remained at the University of Kansas until 1903, when he went to Stanford. With the exception of two years, while he was on leave as chief of the division of chemistry of the Public Health Service, in Washington, D. C., he served in Stanford until 1929, when he retired as professor emeritus.

Doctor Franklin was the recipient of many distinguished honors. Among them were honorary degrees from Northwestern University, Western Reserve University and Wittenberg College. He was a fellow in American Academy of Arts and Sciences; a member of the National Academy of Sciences, of the American Chemical Society (president one year), and many other learned



E. C. FRANKLIN

societies. He was the guest of the British Association for the Advancement of Science at Capetown and Johannesburg in 1929. The Nichols medal was awarded him in 1924 and the Willard Gibbs medal in 1931. He became a member of the Kansas Academy of Science in 1884.

While Doctor Franklin is known for his outstanding work in the ammonia system of acids, bases and salts, he was none the less a great teacher. His resourcefulness, ingenuity and skill provoked the admiration of his students and at the same time spurred them on to do more intensive work themselves.

His intense interest in science did not keep Doctor Franklin from forming many lasting friendships. Nothing suited him better than to take a long trip with his friends into the wilds of the Rocky Mountains to study and admire the wonders of nature.

Doctor Franklin was married July 22, 1897, to Miss Effie June Scott, who died in 1933. Two children survive them. They are Mrs. Anna Comstock Barnett, Stanford University, and John Curtis Franklin, of Kansas City.

John Payson Drake—1866-1936

John Payson Drake, the son of Thomas Thayer and Emily Ann Jenness Drake, was born May 26, 1866, at Pittsfield, N. H. His early life was spent in Pittsfield and Bristol, N. H., where he received his elementary education. He was graduated from Tilton Academy in 1885, after which he taught in the public schools of Bristol for two years.

He received the bachelor of arts degree from Wesleyan University, Middletown, Conn., in 1893, and the master of arts degree from the same institution the following year. He did graduate work for six summer sessions in the

JOHN P. DRAKE

biological laboratories of Cold Springs Harbor, Mass., the University of Wisconsin, and the University of Chicago.

After teaching for six years in high schools in Wisconsin and Illinois, he became head of the physics and chemistry department in the new Western Illinois Teachers' College, Macomb, Ill. In 1914, after a service of thirteen years, he came to Kansas to become head of the department of physics in the Kansas State Teachers College of Emporia. He remained in this position until the time of his death, October 6, 1936.

Professor Drake was married June 22, 1899, to Miss Hattie Pearl Krum, at Stevens Point, Wis. He is survived by his widow and three sons, Russell P., of Albany, N. Y., Herbert T., of Kingman, Kan., and Richard F., of Chicago, Ill.

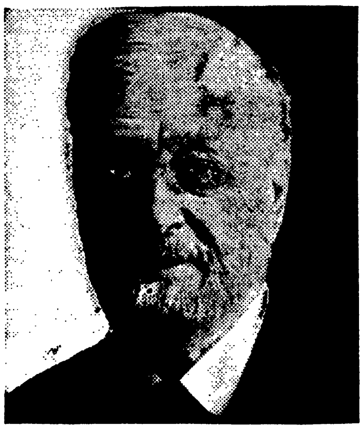
He was a lifelong member of the Presbyterian Church, also of the Masonic

Lodge, being a Knight Templar. He always took an active interest in civic affairs and was a member of the local Kiwanis Club. He became a member of the Academy in 1930.

JAMES MORTON MCWHARF—1841-1937

James Morton McWharf was born in Rose, Wayne county, N. Y., December 17, 1841, and died March 20, 1937. He was married March 26, 1865, to Miss Lucy Stryker. Their wedded life of more than seventy-one years was brought to an end by the death of Mrs. McWharf in April, 1936. The two sons born to Doctor and Mrs. McWharf died in early life. A brother, George McWharf, lives in Wolcott, N. Y. A sister, Mrs. Maryett Sowers, lives in Rose, N. Y.

Doctor McWharf began his secondary education at Moravia, N. Y., finishing it at Falley Seminary, Fulton, N. Y. He received the degree of doctor of medicine from the medical school of the University of Buffalo in 1868.



JOHN W. MCWHARF

After a general practice covering eighteen years in Chautauqua county, N. Y., he came to Fort Scott, where he practiced medicine until he removed to Ottawa, early in the twentieth century. After taking graduate courses in medicine he restricted his practice to the treatment of eye, ear, nose and throat ailments. He retired from active practice a number of years ago.

Doctor McWharf became a member of the Kansas Academy of Science in 1902. He served as president in 1911-1912. He was a member of the state legislature during his early membership in the Academy and rendered valuable service to the Academy in obtaining legal recognition for it. He was a member of the first class to graduate from the Chautauqua Literary and Scientific Circle, at Chautauqua, N. Y. He was active in the Baptist Church and its organizations. He served as president of the Kansas Baptist convention in 1897 and 1898. For seventeen years he was a member of the board of trustees of Ottawa Univeristy.

ROY RANKIN, *Chairman.*
J. E. ACKERT.
R. H. BEAMER.

RESOLUTIONS

The resolutions committee presented the following:

Be it resolved:

1. That the Kansas Academy of Science extends its thanks and grateful appreciation to the Kansas State College for the excellent facilities furnished the Academy for conducting its various sessions.

2. That we extend our thanks and appreciation to the local committee for their excellent work in arranging for the convenience and comfort of the members and guests of the Academy.

3. That we commend the Kansas State College, the Science Club and the Manhattan chapter of Sigma Xi for sponsoring the instructive and inspring address by Dr. Charles F. Hottes.

4. That we convey, through our secretary, our sincere gratitude to Dr. Charles F. Hottes for his very excellent illustrated address.

5. That we appreciate the generosity and efforts of A. J. Griner, the Gaumont British Picture Corporation, H. E. Erickson and the Erpi Corporation, and Steve Smith, of the Hall Stationery Company, in providing the demonstration of teaching sound films.

6. That we extend a vote of thanks to the Science Club and the patrons of the Manhattan Senior High School for providing program facilities and entertainment for the visiting members of the Junior Academy of Science.

7. That as a very special expression of our sincere gratitude and appreciation, we thank Mrs. A. B. Reagan for her graciousness and generosity in establishing the substantial Albert B. Reagan memorial endowment, honoring the memory of her late husband, a long and faithful life member of this Academy.

Be it further resolved, That the secretary of the Kansas Academy be instructed to furnish Mrs. Reagan with an appropriate copy of this resolution.

Signed: J. Ralph Wells, *Chairman.*
Emil O. Deere.
John M. Michener.

NOMINATIONS

We, the undersigned committee on nominations for the elected officers of the Kansas Academy of Science, report the following nominations:

George A. Dean, president, Kansas State College, Manhattan; W. H. Shoewe, president-elect, University of Kansas, Lawrence; H. H. Hall, vice-president, Pittsburg, Kan., K. S. T. C.; Roger C. Smith, secretary, Kansas State College, Manhattan; H. A. Zinszer, treasurer, Fort Hays Kansas State College, Hays.

Three additional members to the executive council—Lawrence Oncley, Southwestern College, Winfield; J. H. Doell, Bethel College, Bethel; R. H. Wheeler, University of Kansas, Lawrence.

Managing Editor: W. J. Baumgartner, University of Kansas, Lawrence; term expires 1940.

Associate Editors and Members Editorial Board—G. A. Kelly, Fort Hays Kansas State College, Hays, term expires 1940. Louis R. Weber, Friends University, Wichita; term expires 1939; completing the unexpired term of W. W. Floyd, who has left the state.

Signed: W. M. Matthews,
W. J. Baumgartner,
J. W. Hershey, *Chairman.*

PAPERS

SIXTY-NINTH ANNUAL MEETING, MANHATTAN, 1937

Presidential Address:

The Teaching of General Chemistry

LAWRENCE ONCLEY

I feel that it may be somewhat presumptuous for me to address you on this subject. But one must speak on that subject most familiar, or of the greatest interest, to him. Therefore, I must ask you to bear with me while I attempt to say a few things which I believe are of interest to many of you at least.

Chemistry and its study is said to be difficult, or at least it has that reputation, I believe. There are several reasons, perhaps, why this is true. In the first place, it must be admitted that the mass of factual material we are dealing with is tremendous. In general, it is also true that the material dealt with is more or less unfamiliar to the beginning student. He must learn a terminology, almost as if he were dealing with a new language. And it would seem that most students have not had much previous training in delving into the material involved.

One of the first things for which we strive is to enlist the interest of the student. There are many ways of accomplishing this, but it is my belief that the surest way to achieve this end is to see to it that the individual student acquires from the very beginning some definite ideas of the things to be accomplished. For, as has been said, "The way an individual feels about what he knows is more important than the thing he knows, because this determines, after all, his behavior." To accomplish this all the attention we can give to sequence and continuity is advisable. Unfortunately, it is in this regard that many courses err, the result being loss of interest by the student.

It is difficult for us who have been in close touch with our subject matter for some time to actually realize the difficulties with which a beginning student in chemistry must contend. The student must proceed from the known to the unknown. Unknown becomes known as he is able to acquire new facts. He deserves all the consideration we can give him, and it is our conviction, after many years of teaching, that the average student begins with the sincere hope and expectation that he will succeed. If it is at all possible we should be close enough to him so that he can settle the difficulties as they arise. Students who are not of this persuasion will normally soon drop the course, and it is well that they do so. Any subject in the curriculum which does not demand the best effort the student can give it can hardly deserve a place.

It is with regard to these facts that we have tried to develop our approach to the subject at Southwestern College during the past seventeen years. How well we have succeeded is open to question, no doubt, but at least we have had an ample opportunity of trying to improve our teaching technique.

In the first place, it is our conviction that, as a general rule, we include too much material, or at least unrelated material. Every student has a certain amount of resistance to new ideas and sooner or later reaches what we may call the saturation point. While it is a good plan to have sufficient matter included so that the more apt student will retain his interest, it is well to

remember that there are many other sources of information to which he may be referred. We forget sometimes, I fear, that we are actually teaching courses in general chemistry. If the individual fails to get some adequate comprehension of the entire scope of chemistry he has not accomplished the end for which it was intended.

With these facts in mind, our efforts have led us to make use of a smaller mass of material and to include the most fundamental material. And we would like to say here, too, that we have not hesitated to forsake the traditional historical approach when we considered the needs of the student. The beginner does not need, at this stage, to understand all the mistakes our predecessors have made. Truth and fact as we understand them today are the essential things. There has been but one criterion—that is, the matter selected must never be beyond the capacity of the average student to learn. We have tried to teach in the way that a student learns. Here is no place for pedantry.

Before proceeding further we should like to add, also, that our custom has been to put all students enrolled for beginning chemistry in the same class, whether or not they have had an introductory course in high school, even if the credit needed in the subject was for a student majoring in chemistry, home economics, medicine, or what not. I do not mean to raise the question as to whether this is the best course to take, but only to say that with a full schedule of teaching and a relatively small number of total students, it has seemed the best thing to do. We wish to add that some of the students who had had no previous training in chemistry have done at least as well as those who had a high-school course earlier.

We began about fifteen years ago to provide our own approach to the subject. We wanted to make it more simple, so that everyone who really tried could learn the important principles. Ever since then we have tried new ideas. We thought young people like to dissect things—they try to find out of what they are made. Many new facts and ideas have been developed during that period concerning atomic structures. We studied them in their value from the pedagogic standpoint.

The periodic chart of the atoms was early introduced. The more we studied the developments in atomic structure and crystal structure the more we became convinced of their utility. The fact that many changes have taken place in some rather fundamental points has not deterred us. We were using fundamental concepts which in the main must remain unchanged. We are still convinced that one of the first difficulties in the way of the beginner is the concept of atoms, molecules and ions. Closely related are the terms "acidic" and "basic." They are entirely new ideas. They may learn glib definitions of these entities with no real concept at all. We wish to emphasize that such a concept is of the greatest importance to the student. We have emphasized that a smooth memory definition of a term or concept is not the most important thing. Better, an awkwardly made statement which reveals that the individual has some comprehension of the concept. Experimental work to improve the concept is useful. The structure of solids, liquids and gases is made use of. The outlines of the kinetic theory, the simplicity of structure of the gases, the common gas laws, the Brownian movement, the use of the Van der Walls equation, etc., may be introduced to reinforce ideas of molecules.

We are accustomed to begin the study of atomic structure very early in the course. The terms "oxidation-reduction," and "valence" are delineated in terms of electrons. Students are required to show electron exchanges in the interactions between metals and nonmetals, especially in the laboratory work. As soon as possible we begin to write formulas for simple compounds; then formulas for the salts of the oxygen acids, including all states of oxidation, are required.

We are now in position to write equations involving double decomposition reactions. Almost any combination of salts, acids and bases may be used. The object desired is that the student acquire what we choose to call the integrity of the ions.

After this a careful study of oxidation-reduction is begun. Numerous charts are used, but perhaps the most useful to the student is a chart containing all of the chemical elements, arranged alphabetically, and including the atomic symbols, atomic weights, atomic numbers and the group numbers.

The use of this chart enables the student to learn the symbols of the elements, and by locating the group number he is able to predict the chemical properties of any given element in a general way. At the bottom of the chart is given, also, general formulas for the oxygen acids of each of the groups. They learn the relation also between ortho, pyro and meta acids, and are called on to make use of these in formula writing.

It is generally customary, we believe, to teach students to recognize the state of oxidation or reduction of a given substance during the first semester of good courses in chemistry, as well as to teach them the art of balancing such equations. But we do not believe it is generally considered possible to teach what substances are forming during oxidation-reduction reactions. We realize that we are treading on dangerous ground, but wish simply to emphasize our belief that at this point there's a grand opportunity to teach some very fundamental concepts of chemistry.

The speaker feels greatly indebted to the authors of a work on qualitative chemical analysis, written by Prescott and Johnson, now out of print. His real progress in the understanding of chemistry dates from the time he began to write and balance the seventy-nine oxidation-reduction chemical equations included in that work. We have found that students generally are just as thrilled with the ability to write such equations. Charts of oxidants and reductants and the possible products, when these react, are provided. But the student is encouraged to use his own chemical sense as it is acquired.

Now, lest we be misunderstood, we should like to make the point clear that while the ability to write equations and balance them is very valuable in itself, the chief value to be gained is the opportunity it gives for impressing anew, and perhaps from a different angle than before, some of the fundamental characteristics of the elements. It might be argued that it is impossible to arrive at a satisfactory set of products from the information at hand. We would answer that, while we admit these possibilities, the pedagogic values achieved are, after all, the greatest. A number of oxidation-reduction equations are furnished the student, and here again he has abundant opportunity to test out his knowledge of chemical principles. By the use of these we are enabled to emphasize what we believe are among the most fundamental foundations of chemical science.

In order to reinforce the theoretical ideas we make use of the action of nitric acid on representative elements of the different groups in the laboratory. For example, taking the groups in order, nitric acid reacts with copper to form the cupric ion; with mercury to form first the mercurous ion as long as free mercury is present, then the mercuric ion is produced. By what steps chemical reactions proceed are thus shown. These steps can be easily proved. With aluminum, the aluminum ion is formed; with tin, varied products may be formed, depending on the strength of the acid employed. Stannous ion and ammonium ion may readily be recognized; or the metal may be converted into meta-stannic acid and nitric oxide. Simple tests may be used to demonstrate the nature of the products formed. The fifth group gives an unusually good opportunity to study the differences in chemical behavior of the elements. Beginning with phosphorus, the action of nitric acid produces phosphoric acid. Whether phosphorous acid or phosphoric acid, or even meta- or ortho-phosphoric acid, is produced can be readily told by the action on silver nitrate. With arsenic we get arsenate ion, which may be precipitated as the magnesium ammonium salt and weighed, or the product may be used in the Marsh test to show that arsenic is present. Antimony and nitric acid yield antimonous or antimonic oxides, but no nitrate, the insolubility of the product formed being proof of it. Bismuth with nitric acid forms the bismuthic ion, which may be precipitated as the basic salt and weighed.

The Marsh test can be included as one of the laboratory experiments to show which elements of the fifth group form hydrides. This group shows in a remarkable manner the effect of atomic structure on chemical properties. These elements are relatively inexpensive for laboratory use, and the by-products may be turned in and the yield reported by each student. To increase interest we have had the students take the mercuric ion produced and convert it into the insoluble mercuric thiocyanate, which may be made up into small cones or pellets and burned to produce what are known as Pharoah's serpents. This also involves tests for the thiocyanate and ferric ions.

It is our purpose now to require more of these inorganic preparations, using larger than test-tube quantities and keeping a record of the yields. This does much to create interest and furnishes a more or less finished product prepared from crude substances which may be used to study the ionic reactions. The student himself prepares some of the actual material he later uses. This may remind us of the old schoolmaster Squeer created by Dickens in "Nicholas Nickelby," who during the spelling lesson calls on one boy to spell horse. The boy arises, performs the task, only to receive the further commission to find the currycomb and brush and then to groom the horse in the stable.

Other suggestions will stimulate one to think of many more relationships that may be introduced. The idea, of course, is to show the relation of chemical structure to chemical properties, or chemical properties to chemical structure, even. From the standpoint of the student, he has acquired what we believe to be the method of science. Not too theoretical, but the theoretical is tempered by the practical.

In such a course as outlined we can cover a relatively large amount of material in a very general manner.

Regarding the proper time for introducing oxidation-reduction equations, we have had an interesting experience. We formerly presented it to major stu-

dents during the senior year. Next, a better place seemed to be to second-year students, or during the course in quantitative analysis. Then it was used during the second semester of the first year. Now we are quite convinced that its utility is of such nature that the real place to include it is during the first semester. And we believe it can be of the greatest utility when presented as soon as possible during the first semester, say earlier than the second half of the first semester. Teachers will not agree with us on this, perhaps, but this is our conclusion. The early use of the principles used in oxidation-reduction is justified when we realize that much of subsequent work in the first year depends upon this viewpoint, and therefore warrants its use.

With this approach we are able to include the study of the elements, oxygen, hydrogen, the halogens and nitrogen quite thoroughly, and in a general manner the metals and practically all the remaining elements, during the first semester. We must, of course, also include a thorough consideration of the subjects, solutions, equivalent, molecular and atomic weights, among other topics.

The work of the second semester is given entirely to qualitative analysis. With the ability to write and balance almost any type of equation already accomplished, the student gets further practice in writing equations. Our experience shows that nothing helps so much to round out the year of study in general chemistry as the necessity for reporting correctly the content of a number of unknowns. The student is put strictly on his own initiative and required to make out his own written report. We then go over this report with each student, and if his results do not check with his report we send him back to the laboratory for a general checking before making his final report. In this way we are able to correct a number of errors, and also have an opportunity to check on his accuracy. This work has a high pedagogic value, in our judgment.

I have sketched for you, in a general way, a description of what we consider a good course in general chemistry. Before closing, however, I should like to remind you, particularly you who are teachers of general chemistry, that we are teaching the teachers of tomorrow. After all, the teacher teaches much as he has been taught. It is true that we, as teachers of chemistry, adjust ourselves to the pedagogical ideas of our time. In general, we may say that the accomplishments of modern education are far from satisfactory. There is too much misdirected energy. At the present time several large high schools and state institutions are carrying out experimental work to show whether students who do not follow the regular high-school curricula, but who are permitted to take up subject matter more suited to their needs or likes, will not produce a better trained college student than those who follow the regular traditional curriculum. Some of these students are already asking for admission to colleges and universities. So far as they have been put on trial, their records have been reported as satisfactory. Educators are saying today that "Science makes the curriculum static." This is certainly not what it should do. Scientists pride themselves on their openness of mind; their willingness to drop any idea when the evidence proves it no longer tenable. I might amplify this subject further, but I hope we shall have a later report from the committee to study trends in secondary schools.

Effects of Ultrashort Radio Waves and Ultraviolet Light on Microörganisms

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This investigation was carried on at the University of Nebraska from 1931 to 1933, on the theory that all particles of matter have their vibration frequency and that if the frequency of a given particle be struck, the particle might be caused to disintegrate or at least change its structure. It is assumed that the proper frequency might be any wave of the electromagnetic spectrum (*2*) or a harmonic of these waves. The writer was especially interested in the range of the short and ultrashort radio waves, but experimented also with ultraviolet light.

At that time there had been practically no experiments with the effects of radio waves on plants. Gosset *et al.* (*3*) had experimented with *Bacterium tumefaciens* tumors and found that they were reduced by a wave length of two meters. Doctor Whitney and some of his colleagues had developed their "Radiotherm" for the treatment of some forms of epilepsy, using waves of about 26 meters length while Doctor Headlee (*1*) and some of his coworkers were killing insects with a "wave length of about 24 meters."

In the experiments described here, several hook-ups and tubes were tried, but the circuit described by Schereschewsky (*4*) was used with the irradiation chamber closely coupled to the 210 tube used as an oscillator. A standard power pack was used, delivering a total of 450 volts filtered d. c. The chamber was made of two sheets of 20-gauge aluminum held apart by bakelite spacers.

Cultures of *Bacterium vesicatorium, Actinomyces scabies, Saccharomyces* spp., *Alternaria solani, Cephalosporium* sp., *Diplodia zea* and *Gibberella saubinetii* were grown on ordinary potato dextrose agar in 10cm. Petri dishes. The filamentous fungi were transferred by cutting a piece of the mycelium with a loop while the others were inoculated as pour cultures. After 24 hours incubation at room temperature, the cultures were irradiated by placing them in the chamber where they were left the desired length of time with the set tuned to resonance. The chamber was large enough that two plates could be exposed at the same time. The controls were placed in the room in the same position, but outside the field of energy. They were exposed for periods of from 4 to 217 hours with wave lengths of from 27 to 45 cm. (They may have been harmonics rather than fundamentals.) At the end of the period of treatment the dishes were all placed back in the incubator until ready to be read, which was 48 hours in most cases. With the bacteria, yeast and Actinomyces, cultures were fished from the colonies and placed on other dishes or in tubes to see if they had been killed. The others were examined for sectoring, radial growth, color variations and lethal effects.

Bacterium vesicatorium was killed in all cultures at 35 cm. when exposed 24 hours or longer, except one dish of 26 hours, which showed slight growth. A number of dishes treated 22 hours showed slight growth afterwards. Other wave lengths had no apparent effect. *Actinomyces scabies* was treated only with waves of 45 cm., but up to 49 hours treatment had no effect. *Saccharo-*

myces spp. on both nutrient and potato dextrose agar showed no difference under threatment at 35 and 45 cm. up to 120 hours. *Alternaria solani* was irradiated with waves of 45 cm. up to 76 hours with no effects below 72 hours. On those exposed over 72 hours there was apparent a slight stunting, but it may have been due to other factors. Cultures of Cephalosporium irradiated at 45 cm. for 48 hours showed some stunting while no difference was noted on those exposed at 35 cm. up to 80 hours. A single culture at 35 cm. for 100 hours was considerably stunted. *Diplodia zea* showed a slightly lighter color after 120 to 217 hours at 35 cm. *Gibberella saubinetii* showed much sectoring at 29 cm. after 48 hours treatment and was smaller and lighter after treatment with 37 cm. waves for 48 hours.

Experiments with cultures of *Alternaria solani, Gibberella saubinetii* and three strains of *Fusarium moniliforme* under ultraviolet light were run concurrently with the radio treatment. Stevens (*5*) had succeeded in getting the ascigerous stage of certain *Fungi imperfecti* due to the action of the rays on the organisms, or, as some thought, due to changes in the media as a result of the heating.

In the work here a General Electric mercury vapor lamp of the Hanover type was used without filters, according to a technique worked out by Frink and Olson (unpublished work at Nebraska University). The lamp was suspended at a height so it would be 28 cm. above the centers of the circle of dishes sitting on a wire screen supported by large corks. The dishes and support were covered with a sheet of sterile cellophane to prevent possible contamination. Usually a cloth wrung out of fifty percent alcohol was placed under the dishes on the screen to prevent excessive heating of the cultures, but even then the temperature went as high as 68° C. at the end of one hour of treatment. After the lamp was heated (usually about 5 minutes), the covers were removed from the dishes for varying lengths of time. After treatment the dishes were incubated again for one week; they were then examined for radial growth, sectoring and color.

Cultures of Alternaria exposed 5 and 10 minutes showed more than ordinary sectoring with heavy sporulation; above 10 minutes the cultures were either killed or severely stunted. A suspension of spores in sterile tap water was exposed for periods up to one hour with samplings at intervals which were plated out and others at the same time placed under the microscope for examination. A control on this showed that the spores started germinating at the end of 10 minutes and at the end of an hour eighty percent of the control spores were germinated. Examination of the treated spores showed a similar rate of germination. The two were left as hanging drop cultures for 24 hours and examined again. Those which had been exposed to the ultraviolet light had made no growth while the controls had made much growth. Those plated out were examined after 72 hours incubation. One sample taken at 35 minutes showed a few colonies while all others which had been exposed 30 minutes or more showed none.

An experiment was conducted with the other forms to find the effects of successive exposures. A control was run for each one. A series was exposed for 5, 10, 15, and 20 minutes, one set once only, another on two successive days, and a third for three successive days. They were all examined seven days after the first irradiation. The controls were placed on the screen with

the treated to check on the temperature effect. The only difference was that they did not have the covers removed. The Fusaria showed effects of stimulation from the rays when exposed at least 15 minutes (total) as compared with those which were merely heated. The Gibberella showed distinct signs of stimulation after 20 minutes. However, we find less growth on those which were treated successively or for longer intervals than those receiving less heating. The color grades uniformly darker with either longer or more irradiation, shading from a pale cream to a purple black in those receiving the longest exposures, either of radiation or of heat. Sectoring was found only in one strain of Fusarium which had been exposed for three twenty-minute intervals. The sectors were the same size on both the control and the irradiated; but that on the control was always darker than that on the treated.

From these experiments one might conclude:

(1) There is a possibility of being able to treat disease by radio waves; but the wave length is probably different for each organism, which would necessitate considerable experimental work.

(2) The effects of unfiltered ultraviolet light may be largely, if not entirely, heat effects.

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Botanical Notes, 1936

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The year 1936 in eastern Kansas will be noted for considerable variation in its weather. During most of the summer the air was exceedingly dry and the temperature unusually high. Both of these conditions had pronounced effects upon the plant life. Unfavorable weather of the two previous years naturally affected the situation this year.

There was a scarcity of the smaller ragweeds (*Ambrosias*), of the blazing stars (*Liatris*), and of the golden rods (*Solidago*). Many trees, weakened in previous years, gave up the struggle. In this we have good evidence that a similar combination of conditions has not prevailed for years, as many of the trees were at least fifty years old. The elms were helped some by the scarcity of the leaf-devouring worms of previous seasons. Other plants—shrubs, garden plants, wild and cultivated grasses—also died. Roses died in gardens that up to this time had managed to grow successfully.

Some plants were scarce at the usual blooming time and were abundant later. The wild blue sage (*Salvia azurea grandiflora*), the common sunflower (*Helianthus annuus*) and the wild asters (*Aster* spp.), especially those that belong on the rocky hills, were among these.

In contrast some plants seemed not to mind the heat and drought. Various species of *Euphorbia* and other spurges were vigorous and abundant. A striking example of this was the condition of some upland prairies, east of Florence, Kan. A species of *Hymenopappus* was the most noticeable plant as seen from highway 50 S. In places where the usual prairie grasses had largely disappeared, cheat (*Bromus secalinus*) had stepped in quite promptly—a fact not greatly pleasing to cattlemen.

We can speak at least one good word for the drought. While the apple trees at our home in Emporia were rather strongly infected with the aecidium stage of the common cedar apple (*Gymnosporangium juniperi-virginianae*), there are few if any telial galls on the cedars at this writing, in March, 1937. In previous years we have destroyed many of the galls in an attempt to rid our garden of them.

There were numerous other very noticeable results of the recent extreme climatic conditions. For some time, the fairy elm, or broomweed (*Amphiachyris dracunculoides*) has colored the prairies a beautiful gold in the autumn. In the fall of 1936 they were almost out of the picture.

In the spring of 1935 there were countless millions of blooming plants of the Carolina windflower (*Anemone caroliniana*). They colored the prairies as with snow, or less conspicuously, if the pink or purplish varieties prevailed. In the spring of 1936 there was scarcely a dozen flowers found.

The year 1936 had more than one superlative. Just as the fairy elm and the Carolina windflowers had been "stars" on the stage in 1935, a rather commonplace flower—a daisy fleabane (*Erigeron ramosus*)—dominated the stage in 1936. Like a meteor, it came on without any noticeable warning to us. Many prairies were snowy with it. It alarmed the farmers, as it seemed to have taken possession of the grasslands. By the first of October it had disappeared,

and as it is an annual and the summer heat had been intense, it may not reappear in numbers soon. It was as abundant in northern Kansas and southern Nebraska as here.[1] We observed it as far south as Sedan in Kansas.

During the later summer, if one took a drive through the regions near Emporia, he would have been reminded of the plagues of Egypt. The hills were as brown as in winter. The grasses were dead looking and as dry as tinder. The roadside plants were heavy with dust. Numerous fires were burning by the highways. Some of the wheat fields were uncut—rendered worthless by drought and insects. Sweet clovers were leafless. This was also true with the sumacs, but here the grasshoppers had even eaten the bark from the stems and these were white and ghostly. Cornfields were barely recognizable but were rows of mere stubs, and even these had disappeared in some cases. Instead there were only holes marking where the stalks had been. The hoppers had devoured all of the plant above ground. These insects had likewise eaten the pulpy portion of the young peaches, leaving the bare pits to represent the fruits.

The dry vegetation was indeed a fire hazard and considerable damage was done from the fires started through carelessness. In the city the fire department had to make numerous runs to extinguish fires on vacant lots.

On February 9 of this year (1937) we noted an unexplained phenomenon. The ground beneath several white elm trees was strewn with hundreds of the flower buds of these trees. We have not accounted for this. The buds seemed entirely normal.

Several times during 1936 henbit (*Lamium amplexicaule*) has proved to be a pest of high rank. A large lawn in front of St. Mary's hospital, Emporia, was reseeded in the fall of 1936. At this time it is almost a pure stand of henbit.

The writer's wife brought some plants into the house in the fall to prevent freezing. One day she noted a movement in the air above one that resembled flying dust. On closer examination she discovered that the particles were tiny grasshoppers, the eggs of which had been brought in with the earth. Later some window plants were found to have been partly eaten by hoppers of noticeable size. We wonder what this may presage for the coming year.

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Notable Trees of Kansas: III

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A GOOD SAMARITAN TREE

Not all trees are outcasts among their fellows, nor are all "on the road to Jericho." This black walnut is beside highway number 13 in the flint hills on the road to Matfield Green. The Kirk family have lived in their present location for two generations and have not only been comforted by the often welcome protection of this friend, but have also been nourished by the abundant bounty which it has lavished upon them.

The "Good Samaritan" not only gave of his sympathy and good cheer, but he added oil and wine to relieve the situation. This walnut has added the equal of the oil and the wine in a never-failing supply of cool, refreshing water from a near-by well. Imagine what a combination this is, and especially under the circumstances. Recall the hot summer days that are not a stranger to Kansas weather. Be reminded, also, that the tree and the well are beside the trail along which many thousands pass and have passed for decades. The early mail carrier was a regular visitor who usually reached this part of his round in the afternoon with his hot and tired horse. Many a traveler has welcomed the cooling shade and the refreshing water. Scores of people making their way for the opening of "The Strip," found this a haven. Groups of Indians, in passing, availed themselves of the chance to quench their thirst and to permit their ponies to do likewise.

Like the Good Samaritan of old, the tree and its companion, were no respecter of persons. All comers, regardless of color, or station in life, were equally welcome and all availed themselves of it. Even in this later day the humble "flivver" of any vintage, the car and trailer, and the stately limousine receive equal privilege and attention.

The story of these two beneficent companions is not finished. Both are readily noticed. The Kirk family mail box is a plain marker for the tree. It is likely that other generations may live to call both the tree and the well blessed.

A FIRE-TESTED TREE

Of the many tragedies that have been enacted on the plains of our state, probably few are known. Parts of some can be pieced together. Humble graves, far from formal cemeteries, quite certainly give evidence of dark hours in the lives of some persons. When the grim reaper struck down his victim on the wide, unmarked prairie, the anguish and despair of his companions must have been most nearly unbearable. Only simple and hurried burials were sometimes possible, and often no mark whatever could be placed to denote the spot for later days.

We are reminded of such past events when we learn the partial history of a noted tree of the prairie lands to the west. Not far south of the Great Bend-Dodge City section of the old Santa Fé Trail, marks of which are still visible,

1. Papers I and II of this series were by Frank U. G. Agrelius and Helen I. Schaefer, Trans. Kans. Acad. Sci., 38:93-98, 1935, and 39:—— 1936.

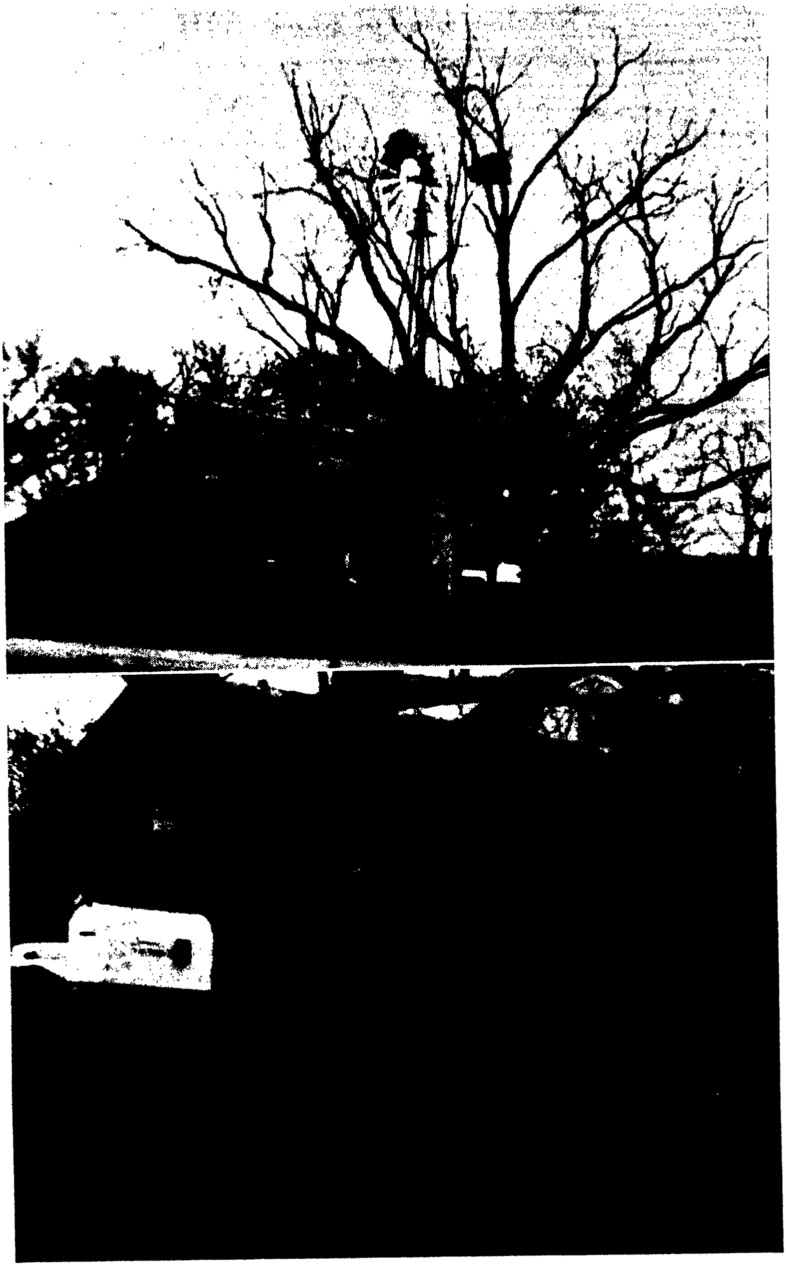

FIG. 1. The Good Samaritan Tree

is a lone rock-elm tree. It is eight and one half miles north of St. John, Kan., near highway No. 8, and the farm of Mrs. Dora Hahn. It is quite probable that it was easily visible to the early travelers on the noted trail nearby. Certain it is that it led an extremely difficult existence for many years. Buffaloes may have damaged it in many assaults. But what was far worse, were the scorching blasts of the prairie fires. In spite of all of these hardships, it persisted. Its origin is not known to the owners. It may be that it is the mark of a tragedy of the early days. A conspicuous object from the renowned multiple-laned trail, it may have been chosen as a suitable spot for the burial of some who had succumbed to the hardships of those early days. True it is that it marks the site of three graves. Another possibility is that friends of the dead laid them to rest here and marked the site with this tree. Certain it is that forty-two years ago, Mr. Walter Hahn decided to move the tree, which was then apparently but a sapling. Upon attempting this he discovered that it had too much root development to permit this with safety to the tree. In spite of the many fires that had burned it to the ground, it had endured and survived them all.

Because of the fact of its struggle to live and also because of the three graves near it, Mr. Hahn, previous to his last illness, requested that the tree be allowed to remain. This has been done and it is still observed by many travelers as was true in the days of the old Trail.

It is supposed that the graves mark the resting-places of white people. Naturally it is an old tree. It is large, too. Its girth is ten feet and the spread of its top is nearly seventy-seven feet.

This lone elm is showing the results of its strenuous life, as well it might. It has stood the test of fire and of the severe elements, but has remained faithful to its duty to the unknown dead at its feet.

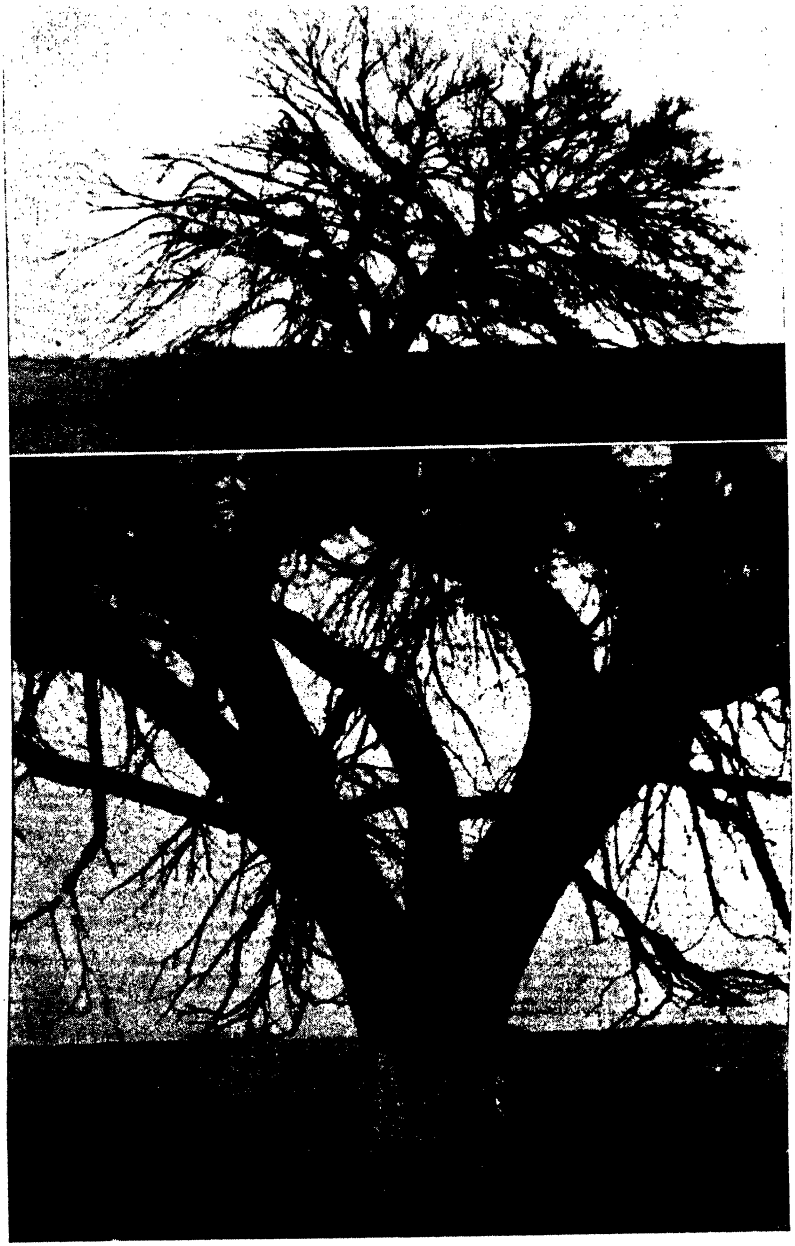

FIG. 2. A fire-tested tree

Some Unrecorded Hosts of *Comandra pallida*, a Hemiparasite

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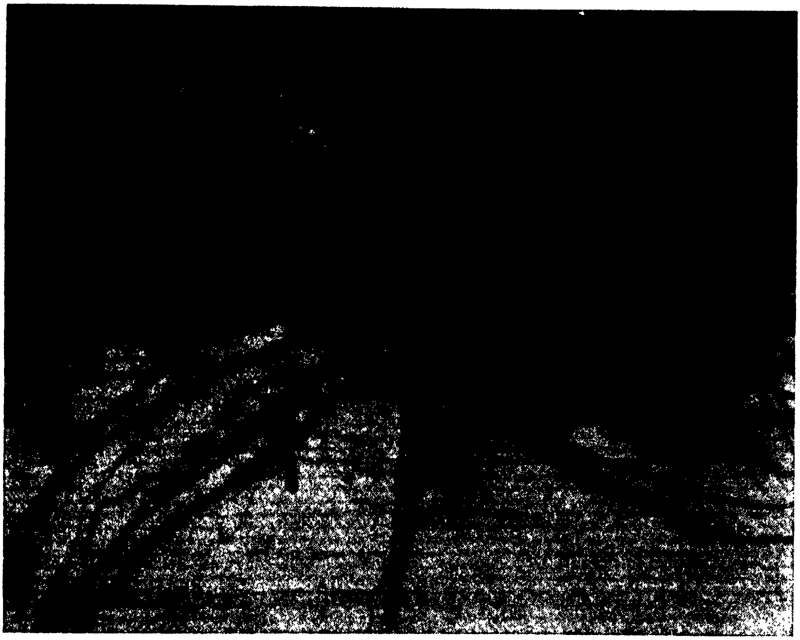
Comandra pallida, A. DC., a hemiparasitic flowering plant, commonly called bastard toadflax, and belonging to the sandalwood family, occurs in sandy soil and on hillsides. Species of this genus, like other santalaceous parasites, have a wide host range, but little has been done to determine the host range of *C. pallida*. It was, however, observed in the Wenatchee district, Washington, by Darlington (*1*) in 1920 on apple. Among the other plants upon which it



Comandra pallida, hemiparasite on *Bonteloua curtipendula*

has been collected in Washington are the peach, sagebrush (*Artemisia tridentata*), lupine (*Lupinus suksdorfii,*) and yarrow (*Achillea millefolium*) (*2*).

The development and structure of the haustoria of the genus Comandra with special reference to *C. livida*, Richards, was worked out by Moss (*3*) in 1926. The structure and morphology of the haustoria of *C. pallida* on apple roots was investigated by Woodcock and de Zeeuw (*1*) in 1920.

The author collected specimens of *C. pallida* in 1935, but was unaware that it was a hemiparasite until Dr. F. C. Gates informed him that there were no specimens in the Kansas State herbarium, for which the host had been collected. In 1936 the hemiparasite was collected by the author on yucca (*Yucca glauca*), sensitive-briar (*Leptoglottis nuttallii*), psoralia (*Psoralia floribunda*),

5—2077

dogwood (*Cornus asperifolia*), American elm (*Ulmus americana*), and sideoats grama (*Bouteloua curtipendula*).

The sizes of the haustorial swellings of these specimens vary considerably in relation to the frequency of infections, therefore it was assumed that the resistance to *C. pallida* varies greatly with the host. Of those specimens collected in Kansas the American elm seems the least resistant, there being as many as three infections to the centimeter. The haustorial swelling may become a centimeter in diameter. The infection of *Cornus asperifolia* is apparently mild and the swellings on the roots were found as large as 2 to 2.5 millimeters. The infection on *Leptoglottis nuttallii* seems approximately the same as on *Cornus asperifolia*. *Yucca glauca* and *Psoralia floribunda* are apparently fairly resistant, having only a few infections for each plant, while the swellings only attain a size of 1 millimeter in diameter. It has been observed that pear and alfalfa growing in the same orchard as peach were highly resistant (*2*). The haustorial swellings on *Bouteloua curtipendula* attain a size of only 1 to 1.5 millimeters, but as this important pasture grass is susceptible to *Comandra pallida*, it should be kept under observation.

The host range of other species of Comandra include the following families of plants: pine (Pinaceae), maple (Aceraceae), willow (Salicaceae), beech (Fagaceae), saxifrage (Saxifragaceae), rose (Rosaceae), cashew (Anacardiaceae), heath (Ericaceae), honeysuckle (Caprifoliaceae), composite (Compositae), carex (Cyperaceae), and grass (Poaceae). The families that *C. pallida* has previously been found on are: rose (Rosaceae), pulse (Leguminosae), and composite (Compositae); while the hosts represented in the author's collections are: lily (Liliaceae), nettle (Urticaceae), mimosa (Mimosaceae), pulse (Leguminosae), dogwood (Cornaceae), and grass (Poaceae). All the specimens collected in Kansas represent new generic hosts for *C. pallida*, and with the exception of the Leguminosae also represent additional families.

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Kansas Botanical Notes, 1936 [1]

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The spring of 1936 was late and long-drawn out, with many frosts and freezes, some of which showed curious effects; for instance, apples and cherries, which normally are immune in this region, were hit irregularly, while peaches, which showed color in the beginning of bud expansion, came through the same freezes without damage. Leaves of Iris were often completely wilted to the ground by freezes, but revived each time.

The first quarter of 1936 was the driest of record, the second quarter showed a little better moisture, but not until fall were there any satisfactory rains. The rains in the fall initiated good growth in many trees and their leaves were not ready for frost. Therefore shriveled leaves remained on several trees long after the first frost. This was most noticeable in species of Ulmus, Acer, *Platanus acerifolia,* and Catalpa. Some *Acer saccharinum* leaves shriveled and remained on all winter.

Winter killing in *Juniperus virginiana* was unusually erratic and severe. Many trees were killed by the late spring freeze which occurred April 3. Many specimens were sent in from over the state for diagnosis, but in almost every case, the trouble was winter injury.

Cones on trees of *Ginkgo biloba* on the Kansas State campus appeared for the first time in 1936.

Drought conditions again were characteristic of the 1936 season. This was shown particularly in forests in eastern Kansas. In many forests ground plants were completely dried sometime during the summer. This made fall collecting the poorest of many years.

Fall flowering of *Chaenomeles lagenaria* (Japanese Quince), apple, mulberry and cherry took place in September sparingly, but many lilacs flowered. *Cercis canadensis* and *Prunus americana* were perhaps the most striking of the woody plants to blossom in October, 1936. Fruiting of oaks was unusually abundant during the year, while elm and maple seeds were scarce.

Bud mutants in variegated geraniums in the greenhouse at Manhattan showed leaves completely green and leaves completely white. Another geranium developed a flower stalk peduncle from the base of a cluster of flowers.

An orchid brought up a year ago from southern Florida blossomed profusely in the greenhouse.

A tree of *Celtis occidentalis* in Manhattan is extraordinarily late in coming into leaf. This tree came from seeds of a tree which also was in leaf about a week later than hackberries in general. This second generation tree is usually two weeks later than ordinary hackberries in coming into leaf. It holds its leaves, however, no longer in the fall than other hackberries. This might prove to be a valuable parent tree if a late hackberry tree were desired for planting where lateness would be a distinct advantage.

An Atlas sorgo plant with abundantly proliferated spikelets was brought in by C. E. Crews from Kingman county in October, 1936.

1. Contribution No. 363, Department of Botany and Plant Pathology, Kansas State College.

In the vicinity of Manhattan, *Amphiachyris dracunculoides* was exceptionally abundant this fall, while *Liatris punctata* (Blazing Star), asters, goldenrod and *Salvia pitcheri* were noticeably less abundant than normal.

The important collections received by the Kansas State Herbarium during the past year included collections by Ben Osborn, assistant regional biologist of the Soil Conservation Service, United States Department of Agriculture, from special areas in Jewell, Allen, and Douglas counties; Clyde L. Merritt, from Crawford county; T. C. Dodd, Jr., from Washington county; B. F. Bush, from Linn county; Mrs. H. L. Brownlee, from Reno county; Miss Emma Maupin, from Stafford county; John Hancin, from Saline county; and my own collections particularly of specimens to show drought effects from Geary, Doniphan and Wyandotte counties.

The checking over of state herbaria was completed during the year and the writing of the catalog of higher plants and ferns commenced. The manuscript on the grasses in Kansas was cômpleted and it will be published by the Kansas State Board of Agriculture.

Kansas Mycological Notes, 1936 [1]

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This constitutes the third annual report in a series of mycological notes mainly applicable to Kansas. The principal objects in issuing these reports annually are to establish a definite record of unusual or important mycological events having a bearing on the agriculture of the state, and to furnish a current published record of the discovery of fungi and bacteria not previously reported for Kansas. The occurrence of organisms on plants, not previously recognized as hosts in Kansas, also is reported. It is our plan to include here, as a matter of record, items that scarcely would seem worthy of separate publication. It is urged that others interested in the matter of the occurrence, distribution, and prevalence of fungi and bacteria, and the diseases caused by them, will join in making this record for the state of Kansas as complete as possible.

The severe drought and high temperatures of the summer of 1936 had a decidedly depressing effect on the prevalence and distribution of diseases of plants. In most parts of Kansas much of the ground cover, including even weeds and native grasses, was either killed or severely injured. In wooded areas the number of ground plants was very limited and in many cases there were none. In situations where the development of fungi usually is favored by shade and moderately moist conditions, shade was reduced by the death of many trees and there was little more moisture than in open situations. In addition to these adverse effects of the weather on the host materials, high temperatures and the lack of moisture reduced and probably often inhibited germination of fungus spores and interfered with infection.

Although conditions were unfavorable for the development of fungi during the summer of 1936, they were sufficiently favorable during the spring months to allow the development of many diseases of crop plants. From the standpoint of applied mycology one of the most interesting developments in 1936 was the occurrence of unusually heavy infections of oat smut. In nearly all parts of the state commercial fields of oats contained large amounts of smut and fields in which twenty-five percent of the panicles were smutted were not uncommon. Infections were heavier in the eastern half of the state than in the western half and the most severe damage occurred in certain south-central counties, including Reno, Harvey, Marion, Butler, Sedgwick, Sumner, and Cowley. In one field in Marion county a count revealed that eighty-six percent of the panicles were smutted, while a field in Harvey county was reported to have ninety-eight percent smut. It is interesting to note that an unusually large amount of the oat smut of 1936 was covered smut, *Ustilago levis*. For many years the predominant smut of oats in Kansas has been loose smut, *Ustilago avenae*, and that species is still the more abundant one. In recent years, however, there has been a gradual increase in the amount of covered smut in the state. This apparent change in the oat smut flora is

1. Contribution No. 366 from the Botany Department, Kansas Agricultural Experiment Station, Manhattan, Kan.

interesting in view of an earlier change of a similar nature. When Kanota oats were first distributed in Kansas in 1921, and for several years thereafter, the variety was comparatively free from smut because of its strong resistance to the physiologic race of loose smut then predominant in the state. In 1926 a race of loose smut to which Kanota was susceptible appeared in southeastern counties and gradually spread northwestward to such an extent that at the end of five years the variety seemed to be thoroughly susceptible. That race of loose smut was introduced into Kansas from the southern states, notably Texas and Oklahoma, where it has been known for many years on Fulghum oats, of which variety Kanota is a strain.

The only other smut of cereal crops that was prevalent in 1936 was the covered smut of barley, *Ustilago hordei*. This smut, which has been increasing in abundance in Kansas during the past five years, was, until recently, more common in fields of winter barley than in spring varieties. Within the past two or three years, however, the disease has invaded the spring barley-producing area of northwestern Kansas and many fields had considerable smut in 1936.

The situation regarding stem rust of wheat in the spring of 1936 afforded an excellent opportunity to study the effect of weather conditions on the development and prevalence of that disease. The state experienced the most severe epidemic of stem rust in its history in the spring of 1935. Although there was little direct evidence of the overwintering of stem rust on winter wheat in Kansas the following winter, infection was sparsely but uniformly distributed throughout the state during late May and early June, 1936. Abundant rains during May seemed favorable for stem rust development and it was feared that the epidemic of 1935 was to be repeated. Temperatures remained too low in May and early June to favor the rapid development of the parasite, however, and in mid-June the rains ceased and temperatures rose very high. The combination of heat and drought ripened wheat throughout the state within a short period and rust development was arrested by unfavorable environmental conditions and a rapidly maturing crop. Only occasional late fields, therefore, were injured by rust.

Because of the severe drought very few diseased plant specimens were received from private collectors at points in the state outside of Riley county, or from government investigators working on grasses, who previously have collected and sent us a number of specimens. We did, however, receive several specimens of Chinese elm, *Ulmus pumila,* the leaves of which were blackened by the fruiting bodies of *Gnomonia ulmea*. Four different specimens of diseased privet that were badly damaged by *Glomerella cingulata* also were received in July. This disease seems to develop best during hot, dry weather at a time when it is necessary to water the shrub heavily.

Ascochyta imperfecta Pk., causing the blackening of alfalfa stems (*Medicago sativa*), appears not to have been recorded for Kansas, although the discoloration of alfalfa has been observed for many years. Typical specimens were collected and the organism identified in 1936.

Owing to the renewed interest in grasses as a result of the soil conservation program of the U. S. Department of Agriculture and the importance of native grass pasture in the agriculture of the state, some attention has been given to diseases of grasses. Very few specimens could be collected in 1936, however, because the plants made so little growth and were dried up so early in the

season. In the irrigated grass nursery at the agronomy farm, Manhattan, where irrigation was practiced, several interesting observations were made. During the latter part of April and early May abundant bacterial blight of bromegrass caused by *Bacterium coronafaciens atropurpureum* was found on the smooth brome, *Bromus inermis*. The rains occurring on April 25, 26 and 27 were largely responsible for this condition, as they provided ideal conditions for infection and incubation of the bacteria during the critical stage in their life history. The affected plants were individual plant selections made by Dr. A. E. Aldous and his associates in connection with their grass-breeding program. These plants varied in their disease reaction from apparently immune to completely susceptible. When these observations were made, the plants were in the junvenile stage, being only about eight inches tall, very leafy, and without panicles. Later in the season when the lower leaves began to dry up, many of them also were found to be severely infected with *Septoria bromi*. In many cases the pycnidia of this fungus almost completely covered the leaves.

Mr. Luther Jacobson collected several plants of crested wheatgrass, *Agropyron cristatum,* that had black, circular to oblong spots on some of the leaves, while others had long, narrow water-soaked streaks. When affected leaves were sectioned and examined microscopically, abundant bacterial oozing was observed from both types of diseased areas. Although the organism was not definitely identified, it seems likely that it is related to that causing the bacterial blight of *Bromus inermis* discussed above. The symptoms on the plants are similar and the bacteria have the same general appearance.

The frequent watering of the various grasses grown in the nursery at the agronomy farm at Manhattan probably was responsible for the abundant development of rust on certain species during the latter part of the season. It was observed in this nursery that individual plant selections of big bluestem, *Andropogon furcatus,* and little bluestem, *Andropogon scoparius,* varied greatly in their reaction to the bluestem rust, *Puccinia andropogonis*. Some plants apparently were immune, while others were completely susceptible. Since the two grasses are excellent for pasture and the resistant and susceptible plants do not differ in vegetative characteristics, it should be possible to select desirable rust-resistant strains for increase. Although no information is available as to that, it seems likely that rust infection not only lowers the yield but also may decrease the feeding value of these very nutritious grasses.

The same group of plant selections that exhibited variability to rust, showed a similar reaction to the smut of bluestem caused by *Sorosporium everhartii*. Although smut infection was not extremely heavy, it was not uncommon to find a few affected florets in about half of the panicles of susceptible plants, while other plants showed no infection. In some cases all of the plants in a family seemed to be extremely resistant or immune, while other families had few to many susceptible plants. The specimens of the organisms collected in 1936 were particularly interesting because the sori and the spore balls showed marked effects of the extreme summer heat. The sori were misshapen and the spores in the center of the spore balls were dark in color. Both of these characters are known to be brought about by unusual ecological conditions. It also appears that this constitutes the first record of the occurrence of *Sorosporium everhartii* on big bluestem, *Andropogon furcatus*.

Another smut on big bluestem was collected in Kansas for the first time in 1936. This disease was caused by *Sorosporium provinciale,* an organism which destroys the entire panicle and which is characterized by spores with very thick walls. The fungus often develops on panicles while they are still in the boot, usually preventing exsertion.

The most interesting grass smut collected in 1936 was that caused by *Sphacelotheca holci* H. S. Jackson on Johnson grass, *Sorghum halepense* (L.) Pers. One specimen was collected by Mr. Donald Cornelius near Howard in Elk county, Kansas. A specimen also was collected by the senior writer near Ardmore, Okla. The organism was identified by Dr. George L. Zundel, who states that it has been described on specimens of sorghum collected in Venezuela, and that he also has since found it among his specimens from the Union of South Africa. The Kansas and Oklahoma collections, however, are the first from North America.

Several hundred chlamydospores of this smut were measured and the average diameter of spores was found to be 7-9μ, agreeing very well with the measurements given by Jackson (*1*) who described the species. The chlamydospores are echinulate and intermediate in size between those of the head smut of sorghum, *Sorosporium reilianum,* and the kernel smuts, *Sphacelotheca sorghi* and *S. cruenta.* They germinate readily on potatodextrose agar or in hanging-drop cultures, producing numerous sporidia that are slightly larger than those produced by the two species of kernel smut mentioned above. The sporidia range in size from 9-13 to 2-4μ, but average 10.5 to 3μ.

Sphacelotheca holci is a typical kernel smut in that the sori destroy the ovaries, leaving the glumes intact. Not only the sessile fertile, but also the pedicellate staminate spikelets were infected. It appears that the sori develop from both the pistillate and staminate tissues as no stamens were observed when the spikelets were infected. In the pedicellate sori, the rudimentary tissue of the ovaries also apparently was infected. The diseased ovaries become very much enlarged as the sori develop. The sori are covered by a very thin false membrane that begins to flake away at the apex almost as soon as the sori become apparent, exposing the very prominent columella. The diseased plants usually are much shorter than normal plants and infected panicles emerge much earlier than healthy panicles. Flaking away and rapid disintegration of the false membrane of the sori, as well as early emergence of the smutty panicles and dwarfing of the plants, are characteristic of the loose kernel smut of sorghum caused by *S. cruenta.* These facts seem to indicate that *S. holci* has a marked resemblance to *S. cruenta* and that it may be more closely related to that species than to any of the other smuts of sorghum.

In the summer of 1936 the seed of six varieties of sorghums, Red Amber X feterita K. B. 2570, Dwarf Yellow milo C. I. 332, Pierce kaferita K. B. 2547, White Yolo K. B. 2525, kafir X feteria K. B. 2686, and Pink kafir K. B. 36706, was dusted with the spores of *Sphacelotheca holci* and planted in the field, but no infection resembling *S. holci* was observed. A few smutted secondary panicles arising by branching of the stalks occurred in inoculated rows, but microscopic examination of the spores from such panicles proved that the causal organism was *S. sorghi.* Such infections did not appear until late in the season after heads infected by *S. sorghi* became numerous in adjacent experimental plots. It seems, therefore, that such cases were the result of local infections of

lateral buds by wind-carried spores of *S. sorghi,* as was reported by Reed and Faris (*2*) for *S. cruenta*. The conditions were ideal for smut infection as about eighty percent of the heads of Pink kafir in another experiment were infected with *S. sorghi.* The spores of *S. holci* were known to be viable because high infection was secured in inoculated plants of Johnson grass grown in the greenhouse at the same time. It appears, therefore, that this new smut does not readily attack all varieties of sorghum, but undoubtedly attacks some varieties since the organism was originally described on *Sorghum vulgare* Pers.

Owing to drought and extreme heat, collections of fungi occurring at points other than Manhattan were extremely meager in 1936. A few collections were made by the writers after the fall rains began in September and a few were received from county agricultural agents, teachers, and farmers. Most of these proved to be organisms that commonly are found in the state, but a few proved to be new for the state. The following is a list of fungi found in Kansas on new hosts or that do not appear to have been reported previously as occurring in Kansas:

Ascochyta imperfecta Pk. on *Medicago sativa* L.
Chaetomella atra Fckl. on *Triticum vulgare* Vill.
Cymadothea trifolii (Pers.) Wolf. on *Trifolium repens* L.
Elvela influla Schaeff. on decaying organic matter.
Epicoccum neglectum Cda. on *Juniperus virginiana* L.
Erysiphe cichoracearum (DC.) Schrt. on *Xanthium strumarium* L.
Gnomonia ulmea (S.) Thm. on *Ulmus pumila* L.
Gonythrichum caesium Nees on dead wood.
Sorosporium everhartii Ellis & Gall. on *Andropogon furcatus* Muhl.
Sorosporium provinciale (Ellis. & Gall.) Clinton on *Andropogon furcatus* Muhl.
Sphacelotheca andropogonis (Opiz.) Bubak on *Andropogon scoparius* Michx.

Although only a few diseased grass specimens were collected in Kansas during 1936, we were particularly fortunate in receiving forty-seven specimens from Texas collected by Mr. Gerald Mott. Despite the fact these were not Kansas specimens, they are of interest from a Kansas standpoint because of the similarity of the grassland flora of the two states. Among these, fungi were found on some species that previously had been free from disease, or that at least had not been mentioned as hosts for those organisms. Some of the more interesting fungi found on the Texas grasses are the following:

Colletotrichum graminicolum (Ces.) Wilson on *Echinochloa crusgalli* var. *mitis* (Pursh) Peterm.
Diplodina graminis Sacc. on *Glyceria striata* (Lam.) Hitch.
Puccinia andropogonis Schw. on *Andropogon scoparius* Michx.
Puccinia boutelouae (Jennings) Holw. on *Bouteloua curtipendula* (Michx.) Torr.
Puccinia cameliae (Mayor) Arth. on *Setaria macrostachya* HBK.
Puccinia cameliae (Mayor) Arth. on *Setaria scheelei* (Steud.) Hitch.
Puccinia graminis P. on *Agropyron smithii* Rydb.
Puccinia panici Diet. on *Panicum virgatum* L.
Puccinia substriata Ellis & Barth. on *Paspalum ciliatifolium* Michx.

Septoria cenchrina J. J. Davis on *Cenchrus myosuroides* HBK.
Septoria sp. on *Stipa leucotricha* Trin. and Rupr.
Stagnospora maritima Syd. on *Manisuris cylindrica* (Michx.) Kuntze.
Tracyella spartinae (Pk.) Tassi. on *Distichlis stricta* (Torr.) Rydb.
Ustilago bromivora (Tul.) Fisch. v. Wald. on *Bromus catharticus* Vahl.

A species of *Phyllachora* occurred on many of the Texas grass specimens and upon examination it was found not to be morphologically distinct from *P. graminis* (P. ex Fr.) Fckl. The asci were 60-100 by 8-12μ and the spores 7-12 by 7-8μ. The hosts upon which this fungus was found were *Andropogon perforatus* Trin., *Sporobolus cryptandrus* (Torr.) A. Gray, *Triodia albescens* Vasey, *Distichlis stricta* (Torr.) Rydb., *Pappophorum mucronulatum* Nees, *Eragrostis palmeri* S. Wats., *Trichachne patens* Swallen, and *Leptoloma cognatum* (Schult.) Chase.

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Some Anatomical Features of *Amsonia tabernaemontana*

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The Apocynaceae are characterized by a whole series of anatomical features in Solereder's "Systematic Anatomy of the Dicotyledons." Some of the more striking of those listed are made evident in an anatomical study of *Amsonia tabernaemontana*, a member of the Apocynaceae. The closest related species referred to by Solereder is *Amsonia latifolia*. *Amsonia tabernaemontana* is a perennial herb occurring along river banks and in woods, chiefly in southeastern Kansas. (Fig. 11.)

THE LEAF

In observing the leaf superficially it appears nearly glabrous, however, along the veins, margin, and sparsely scattered over the lower epidermis, trichomes are found. These, as indicated in figs. 3, 4 and 6, are of the simple clothing hair type. Branched hairs may be found, but are reported to be more common on some of the other species. No glandular hairs were found; this coincides with other members of the Apocynaceae. Cells of the two epidermises have comparatively the same cavity size as seen in surface view, figs. 1 and 2, however, the upper epidermal cells are larger, as indicated in cross section (fig. 10). Their lateral walls vary in that those of the lower epidermis are undulated while those of the upper epidermis are straight. In the stomata no uniform type of structure is present. Stomata occur only in the under epidermis, averaging ninety per sq. mm. of leaf surface. The netted venation of the leaf (fig. 5) has meshes averaging 0.1 mm. across.

A cross section of the leaf indicates it to be of the bifacial type. (Fig. 10.) Each epidermis is covered with a thin cuticle which has been laid down so as to give a striated surface. The mesophyll is composed of approximately one row of palisade cells above, and irregularly arranged spongy cells below. The palisade cells are strikingly small in cross diameter and compactly arranged. For these reasons an approximate count gives 9,000 per sq. mm. of the leaf's surface. The leaf presents one of the chief anatomical characters of the family in that it has latex vessels. Throughout the blade these vessels can be seen following the veins on their lower sides and occurring in the fundamental tissue of the midrib.

THE STEM

A study of the structure of the stem (fig. 8) presents two of the more prominent anatomical characters of the family, in the existence of intraxylary phloem and a latex system. Intraxylary phloem according to Solereder probably occurs in all members of the family; at any rate, no exception is known. It either forms a continuous ring or isolated bundles at the margin of the pith. In *Amsonia tabernaemontana,* the intraxylary phloem is in isolated groups. (Figs. 8 and 9.) I have observed latex vessels within the inner cortex (fig. 7), phloem, intraxylary phloem and pith. The xylem is in a continuous cylinder with xylem rays, one row wide, separated by one to two rows of xylem vessels. Within the cortex isolated groups of primary hard bast are

found, these being nonlignified as indicated by phloroglucine and hydrochloric acid.

THE ROOT

Latex vessels are formed in the cortex of the fibrous roots. This is the only identifying anatomical character found in the roots. The cells of the cortex have an abundance of globules which stain red with Scarlet R.

PLATE I

Amsonia tabernaemontana

FIG. 1. Upper epidermis of leaf.
FIG. 2. Lower epidermis of leaf.
FIGS. 3-4-6. Trichomes from leaf.
FIG. 5. Venation of leaf.

PLATE I

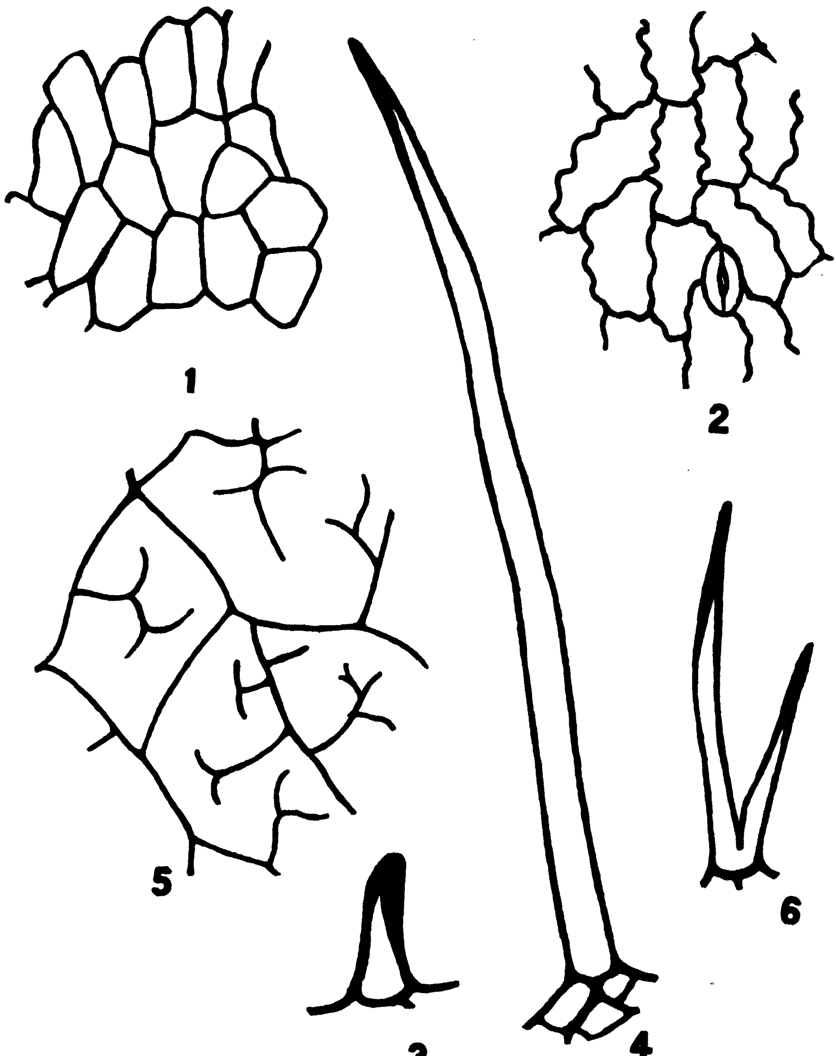
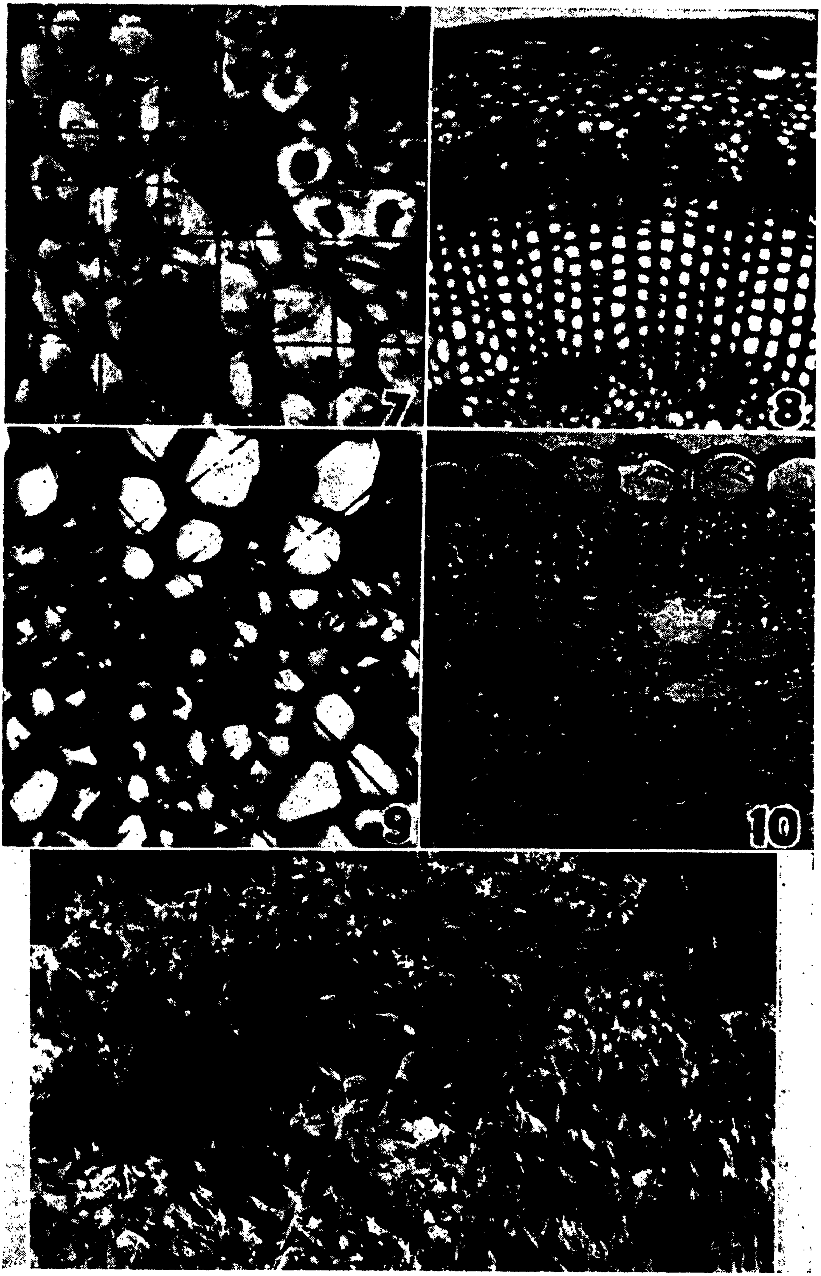


PLATE II

FIG. 7. Latex vessels (in black) within inner cortex of stem.
FIG. 8. Stem cross section.
FIG. 9. Intraxylary phloem at inner margin of xylem.
FIG. 10. Leaf cross section.
FIG. 11. General habit of plant.

PLATE II



A Polygamous Spirogyra [1]

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Until recently the Botany Department at Kansas State College has experienced difficulty in obtaining Spirogyra in fruiting stages during the winter months. Some difficulty has likewise been encountered in getting it to grow well vegetatively in the laboratory except over short periods.

During the last three years, however, we have had good success in both of these phases. The material has been collected and enough tap water added to allow about a gallon of water to a quantity of the alga about twice the size of a thumb. Water was added when necessary. Varying lengths of time have elapsed between collection and fruiting.

During the past winter an attempt was made to collect Spirogyra about the middle of December when the streams were open. Algal material was brought in from a small stream which runs through the campus north of the horticulture building. On examination it was found that the small amount of material which we had been able to find contained no Spirogyra. However, this collection was set aside in its own water, with additional tap water, and in a short time an abundant growth of Spirogyra appeared. This had evidently developed from zygospores.

Fruiting began to make its appearance about the first of February and some of it is still reproducing at the present time, April 21, 1937. The following peculiarities have been noted in the reproduction of this Spirogyra.

1. Both scalariform and lateral conjugation have frequently been seen in the same filament. (See figs. 6, 7a, 7b, and 8.) Although the former type is considerably more abundant, the latter is by no means rare. This condition has previously been described for a number of species of Spirogyra. In the lateral conjugation observed, it is very evident that the septum does not simply become stretched, neither is the end wall perforated as is the method described by a number of investigators. Rather, a conjugation tube is formed by the union of two outgrowths which occur on the side wall near the transverse partition between two adjacent cells. Thus a curved tube is formed. (See figs. 2 and 7a.) Such a formation has been described by Lloyd.[2]

Lateral conjugation is considered by some as rather abnormal, resulting from conditions which are unfavorable to the scalariform method.

2. Several conjugation tubes from the same cell are very common. In a few cases a conjugation tube from one cell has been seen to form a union with two tubes from two different cells of an opposite filament. (See figs. 4 and 5.) This gives a suggestion for a possible origin of polyploidy in Spirogyra in case the three gametes should come together and unite.

According to Brown [3] a profusion of conjugation branches, accompanied by a tendency to form abnormal connections, is probably a response to environmental conditions exceptionally unfavorable for vegetative growth.

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1. Contribution No. 368 from the Dept. of Botany and Plant Pathology, Kansas State College.
2. Lloyd, F. E. Sexual reproduction in water silk. Sci. Mon. 22: 330-340. 1926.
3. Brown, J. G. Abnormal conjugation in Spirogyra. Bot. Gaz. 66: 269-271. 1918.

3. One filament was seen to conjugate with several other filaments at different regions along its length. (See fig. 8.)

4. Several cases were noted of apparent cross conjugation. However, on closer examination, it was quite evident that microörganisms, members of the Chrytridiales, had destroyed the contents of certain of the cells and the cells which at first were believed to contain zygotes contained only single gametes, the other gamete having been destroyed. (See fig. 10.)

5. In a number of cases conspicuous size differences were observed in the gametes, the male gamete being conspicuously smaller than the female gamete. (See fig. 9.) Such size differences have previously been reported as rather regularly occurring in some species.

PLATE I

SKETCHES OF SPIROGYRA PLANTS, SHOWING VARIOUS STAGES OF REPRODUCTION

FIG. 1. Lateral conjugation; migrating gamete.

FIG. 2. Lateral conjugation; development of conjugation tubes.

FIG. 3. Profusion of conjugation tubes.

FIG. 4. Two cells of one filament joined by conjugation tubes to one cell of an opposite filament.

FIG. 5. Two cells of one filament joined by conjugation tubes to one cell of an opposite filament. In this case a zygote has been formed from gametes of two of the cells. The third cell has formed practically all of the tube connection.

FIG. 6. Lateral and scalariform conjugation in the same filament. Zygotes have been formed by both methods.

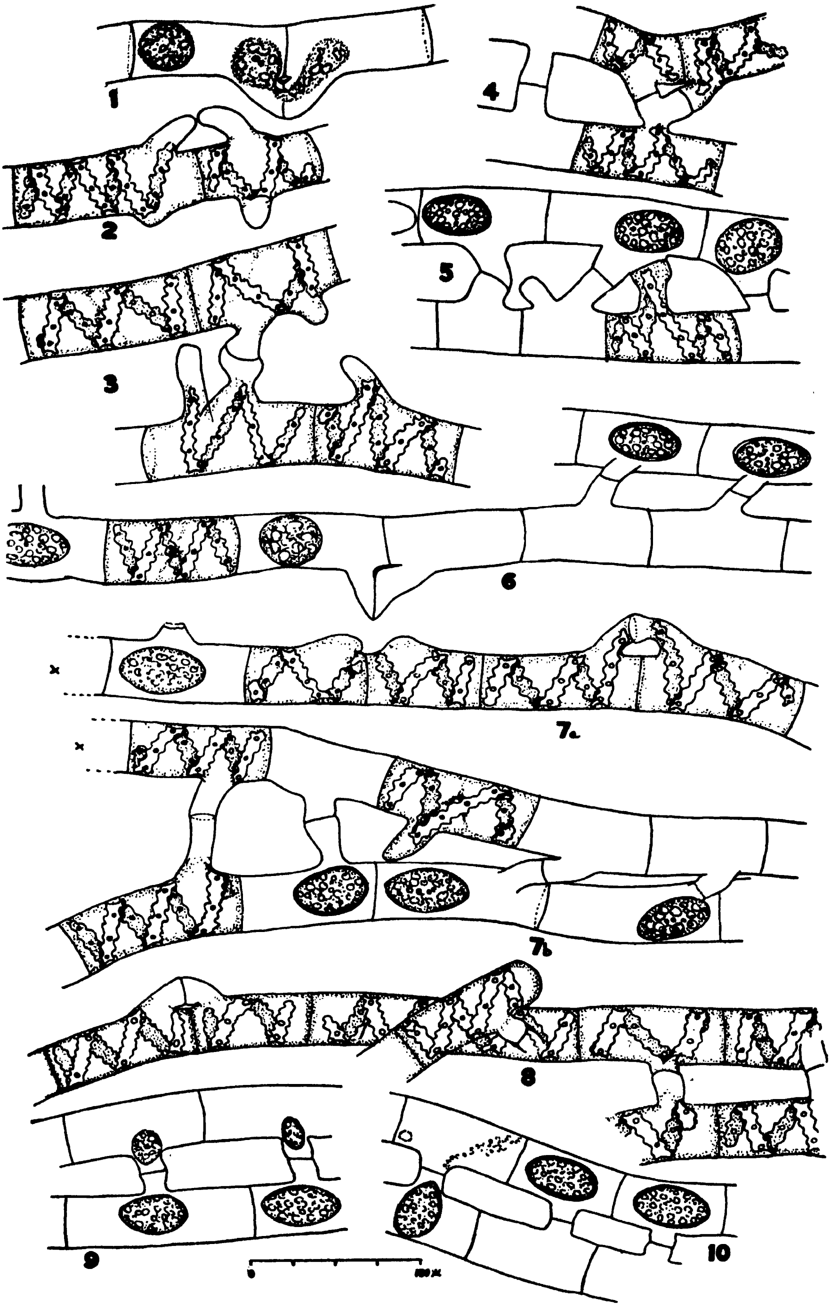
FIG. 7. Lateral and scalariform conjugation in the same filament. Note stages in development of conjugation tubes. *a*, is continuous with the upper filament *b* with 4 vegetative cells omitted.

FIG. 8. One filament conjugating with 2 other filaments at different regions along its length. This plant also shows lateral conjugation.

FIG. 9. Filaments showing conspicuous size difference in gametes from the 2 conjugating plants.

FIG. 10. Apparent but not actual cross conjugation. Note indications of parasitism in one of the cells. Upper left-hand cell shows opening made by the parasite.

PLATE I



Studies on the Host Range of *Sclerotium delphinii* Welch

D. J. OBEE, University of Kansas, Lawrence, Kan.

In a note published previously (*8*) the writer mentioned that A. J. Mix had made an isolation of *Sclerotium delphinii* Welch from *Ajuga reptans*. The organism was observed in a rock garden where in addition to *Ajuga* it was parasitizing *Sedum acre* and *Lysimachia nummularia*. This marked the first time this species had been isolated in Kansas, although *Sclerotium rolfsii* Sacc., a closely related species, is listed by Bartholomew (*1*) as occurring in the state. Figure 1, left, is a photograph of the strain of *S. delphinii* isolated from *Ajuga*, and, right, a typical culture of *S. rolfsii* growing on potato dextrose agar slants.

In the course of a general study of this isolate from *Ajuga* it was decided to investigate the host range and make a few comparisons with *S. rolfsii*. The latter, because of its wide geographical distribution and economic importance as a plant pathogene, has received considerable mention in the literature and is known to be parasitic on nearly two hundred hosts. *Sclerotium delphinii*, on the other hand, has been reported on only about forty species. These have been compiled and are listed in Table I. Unfortunately some workers gave only the common names for some of the hosts, and where there was doubt as to the correct scientific name, either just the genus name or common name is listed.

TABLE I.—Hosts of *Sclerotium delphinii* previously reported with reference by number to literature cited

Ajuga reptans L.	8, 15	Lysimachia nummularia L.	8
Ambrosia sp.	10	Mangivera indica L.	9
Asimina triloba L. (seedlings)	9	Melon	11
Belamcanda chinensis DC.	10	Momordica charantia L.	9
Brassica oleracea var. capitata L.	9	Narcissus sp.	6
Brassica sp.	9	Oryza sativa L.	9, 11
Capsicum annuum L.	9	Phlox sp.	10
Cucumis sativus L.	11	Physostegia virginiana Benth.	6
Cucurbita maxima Duchesne	9	Pyrethrum daisy (Chrysanthemum coccineum Willd. ?)	10
Daucus carota var. sativa DC.	10	Raphanus sativus L.	9
Delphinium spp.	4, 6, 10, 11, 14	Sedum acre L.	8
Eupatorium sp.	15	Sedum sp.	15
Funkia sp.	10	Solanum melongena var. esculentum Nees,	9
Golden banded lily of Japan	10	Tradescantia spp.	10
Iris sp.	2, 3, 5, 6, 10, 12, 15	Tulipa sp.	5, 10, 13
Lagenaria leucantha Rusby	9	Verbena sp.	10
Lilium candicum L.	10	Vigna sinensis Endl.	9
Lilium regale Wils.	6, 11	Viola sp.	10
Linaria vulgaris L.	10	Yellow Daisy	10
Luffa acutangula Roxb.	9		
Lycopersicon esculentum Mill.	9		

Furthur inoculation experiments have shown that *S. delphinii*, like *S. rolfsii*, has a rather wide host range. These inoculation experiments were conducted in the greenhouse. Infection was effected by transferring, by means of a sterile scapel, a small amount of mycelium from a plate culture to the soil adjacent to the roots of a potted plant. In no instance was the pathogene introduced directly either by puncturing or wounding the host plant in any way. While much of this work was carried out in a moist-chamber compartment, infection was also obtained in plants not kept in the chamber. The increased

humidity of the moist chamber, however, did induce more rapid destruction of the host plants. Those species inoculated are listed alphabetically in Table II. The scientific names are taken from Bailey's Manual of Cultivated Plants and Rydberg's Flora of the Prairies and Plains of Central North America.

TABLE II.—Results of inoculation of various host plants with *S. delphinii*. Symbol "D" indicates infection and subsequent death of plant, "R" indicates infection but recovery of host plant, and "O" indicates no infection.

Host plant	*Degree of susceptibility*	*Host plant*	*Degree of susceptibility*
Achillea ptarmica L.	R	Lantana sp.	D
Ajuga reptans L.	D	Lathyrus odoratus L.	R
Agrostemma coronaria L.	D	Lavendula spica L.	D
Althea rosea Cav.	D	Leptosiphon sp.	D
Alyssum saxatile L.	R	Lobelia erinus L.	R
Amaranthus tricolor L.	R	Lunaria annua L.	D
Anagallis grandiflora Andr.	D	Lupinus hartwegii Londl.	D
Anchusa capensis Thunb.	D	Lupinus sp.	D
Anemone sp.	D	Lychnis chalcedonica L.	R
Antirrhinum sp.	D	Lychnis coronaria Desr.	R
Aquilegia canadensis .L.	D	Lychnis viscaria L.	R
Aquilegia (single mixed)	D	Lycopersicon esculentum Mill.	D
Aquilegia sp.	D	Lysimachia nummularia L.	D
Apium graveolens L.	D	Mesembryanthemum crystallinum L.	D
Arabis alpina L.	R	Mesembryanthemum tricolor Willd.	D
Begonia sp.	D	Myosotis sylvatica Hoffm.	R
Boltonia latisquama Gray.	R	Narcissus tazetta L.	D
Brassica oleracea botrytis L.	D	Oxalis rubra St. Hil.	D
Calceolaria sp.	D	Oenothera missouriensis Sims.	D
Campanula carpatica Jacoq.	D	Papaver nudicaule L.	D
Campanula persicifolia L.	D	Papaver orientale L.	D
Carnation sp.	R	Parthenocissus tricuspidata Planch.	R
Centaurea americana Nutt.	D	Pelargonium hortorum Bailey.	O
Centaurea montana L.	D	Petunia hybrida Vilm.	D
Cerastium tomentosum L.	D	Phaseolus limensis Macf.	R
Cheiranthus cheiri L.	D	Physostegia virginiana Benth.	D
Chenopodium sp.	D	Platycodon grandiflorum DC.	O
Chrysanthemum maximum Ram.	D	Polemonium coeruleum L.	D
Chrysanthemum sp.	D	Portulaca grandiflora Hook.	D
Cobaea scandens Cav.	D	Primula sp.	D
Coreopsis grandiflora Nutt.	D	Ricinus communis L.	D
Cymbalaria muralis Gaertn., Mey & Scherb.	D	Rosmarinus officinalis L.	D
Dahlia sp.	D	Saponaria ocymoides L.	R
Delphinium ajacis L.	D	Sansvitalia procumbens Lam.	D
		Sedum acre L.	D
Delphinium chinensis Fisch.	D	Sedum mixed.	D
Delphinium (Gold Medal Hybrids)	D	Solanum tuberosum L.	D
Dianthus barbatus L.	R	Solanum triflorum Nutt.	D
Dianthus deltoides L.	R	Tagetes lucida Cav.	R
Dianthus plumarius L.	R	Tagetes sigmata Bartl.	R
Digitalis purpurea L.	D	Taraxacum officinale Weber.	D
Digitalis purpurea gloxiniaeflora Vilm.	D	Trachymene caerulea R. Graham.	D
Felicia amelloides Voss.	D	Tunica saxifrage Scop.	D
Gaillardia aristata Pursch.	D	Verbena hybrida Voss.	R
Gilia capitata Dougl.	D	Veronica incana L.	R
Gypsophila muralis L.	D	Veronica longifolia L.	R
Gypsophila paniculata L.	D	Veronica teucrium L.	R
Gypsophila repens L.	D	Veronica repens DC.	R
Helianthemum vulgare Gaertn.	D	Veronica sp.	R
Helichrysum sp.	D	Viola cucullata Ait.	D
Hesperis matronalis L.	D	Viola rafinesquii Greene.	D
Impatiens balsamina L.	D	Viola tricolor hortensis DC.	D
Ionopsidium acaule Reichb.	D	Zea mays indentata Bailey.	O
Lactuca sativa capitata L.	D		

Of the 106 host species listed in the above table, only three were found to be completely resistant to the pathogene. These were *Platycodon gradiflorum, Zea mays indentata,* and *Pelargonium hortorum.* A limited number of plants such as various species of Dianthus and Arabis, *Lathyrus odoratus* and *Tagetes sigmata* are listed as being only weakly susceptible, in that while they were infected and showed some symptoms, these plants did not succumb. Of this list of host plants only six are included in Table I, thus adding nearly a hundred hosts to the range of this fungus.

In parasitizing a plant the pathogene generally attacks the stem at soil level, either by completely enclosing the stem base with a weft of mycelium, as shown in figure 2, or sending out rather thick strands of mycelium that only partially envelop the stem (fig. 3), the latter method being the more common. In either event the results are the same. The surface of the affected areas assume a brown water-soaked discoloration. The parts above this soft rotted region wilt, and as infection progresses, the whole plant dies. These stages generally all take place within a week's time.

In conclusion, it is apparent that *S. delphinii* has potentially as wide a host range as *S. rolfsii.* The symptoms induced by the two species are practically identical, and in this connection it is also of interest to note that some of the dissimilarities of these two species so apparent on culture media are not so noticeable on diseased plants. Figure 4 shows *S. delphinii* on *Sedum acre.* The numerous uniformly small and globose shaped sclerotia observed here are characteristics commonly ascribed to *S. rolfsii.* This and the fact that several intermediate forms have been isolated has resulted in some doubt being cast as to whether these are two valid species. However, Stevens (10), Palo (9) and others, as a result of comparative studies made between the two species, are of the opinion that they should be considered as such.

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15. Westcott, Cynthia. Crown Rot of Ornamentals in New Jersey. Plant Disease Reporter. **20**: 193. 1936.

PLATE I

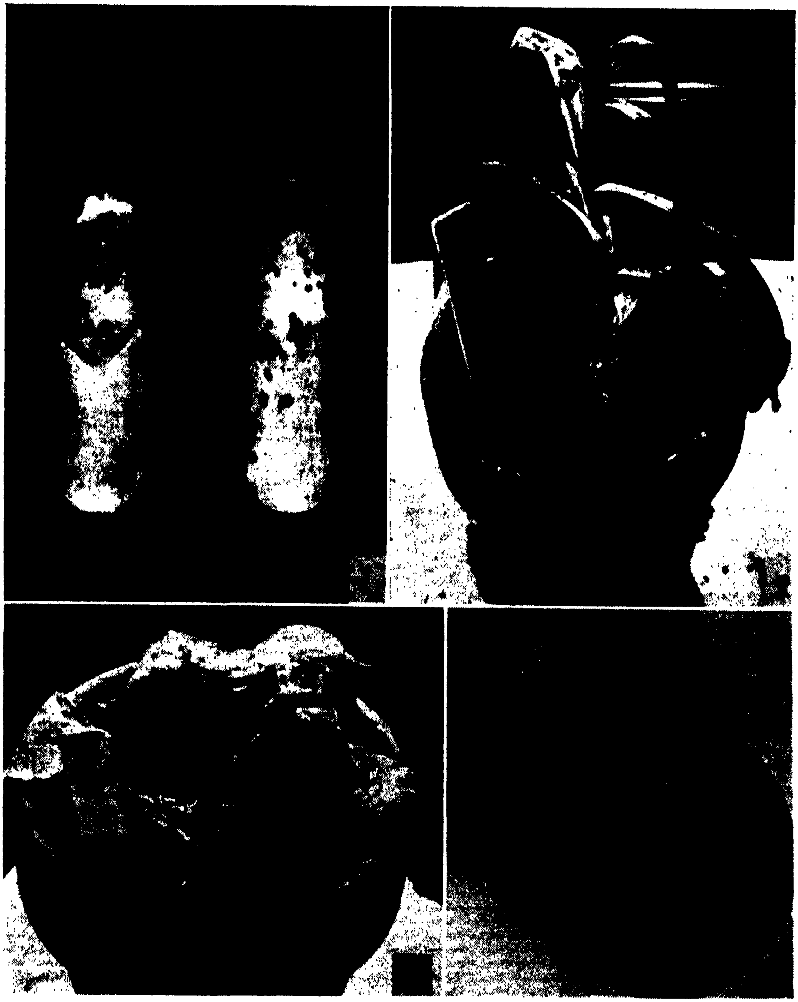


FIG. 1. *Sclerotium delphinii* (left) and *Sclerotium rolfsii* (right) growing on potato dextrose agar slants.

FIGS. 2, 3 and 4. Results of inoculation with *Sclerotium delphinii* of *Helichrysum* sp. (Fig. 2), *Lunaria annua* L. (Fig. 3), and *Sedum acre* L. (Fig. 4).

Cooperia kansensis, n. sp.

W. C. STEVENS, University of Kansas, Lawrence, Kan.

Mr. B. H Hill of Neodesha, Kan., last summer took us to see a colony of Cooperias occupying a high, rocky pasture of the farm of Mr. Howard Hill, his brother, near the village of La Fontaine. Indeed, he gave us two introductions to this colony in its two very strikingly different aspects: First, in May, when the Cooperias appeared above the ground each as a cluster of grasslike leaves only (figs. 2, 3), and again in early September when each plant stood before us as a single flower on a slender scape (fig. 1), unaccompanied by even a vestige of a leaf.

This colony has been familiar to Mr. Hill from his boyhood and through the years he has noticed the unvarying habit of the appearance of leaves only in the spring and of flowers only in late August or early September, always immediately after the first rainfall of that period.

When we first went to the pasture on May 19, two close associates of the Cooperias were in bloom, *Zygadenus nuttallii* and *Opuntia humifusa,* and the Cooperia leaves were in their photosynthetic prime (figs. 2 and 3) and truly in danger of being wiped out by grazing cattle but for their close nestling against the rocks and formidable cacti. At other parts of the extensive pasture where surface rocks ceased and no cacti were growing Cooperias also were absent.

Again, on September 14, we were called by telephone to hasten to see the flowers that had sprung up after the unusually late rains and found them making a gallant show where little else was blooming.

Putting together the two appearances—that of spring and that of late August or early September—this plant seemed to Mr. Hill and to us closer to *Cooperia drummondii* than to any other, but yet not properly belonging to that species as heretofore had been supposed.

In figures 2, 3 and 1 we present photographs of this Cooperia in its widely-separated leafage and flowering stages, done to the same scale, the squares representing square inches. When we place these illustrations alongside those in the manuals for *Cooperia drummondii* the conclusion is inevitable that here we are dealing with a new species. The following name and description will serve as its baptismal ritual:

* *Cooperia kansensis* Stevens, new species. Bulb usually globose, sometimes elongate, about 18 mm. in diameter, proliferating by basal bulblets; leaves erect, extending 18 cm., more or less, above the ground, 4 mm. broad; peduncle hollow, about 4 mm. in diameter; bract spathelike, thin and tubular, closely applied to the perianth tube; flower about 10 cm. long, white, rose-tinted at the throat, tube about 3 mm. in diameter and slightly expanding close to the limb; segments about 18 mm. long, cuspidate; throat about 4 mm. wide; ovary but little broader than the peduncle, cylindrical but sometimes slightly ovate; leafage in the spring without flowers; flowers, without leafage, after rains in late August or early September. S. E. Kansas, on high rocky prairie.

* *Cooperia kansensis* Stevens, nova species. Bulbus usualiter globosus, nonnunquam elongatus, circiter 18. mm in diam., multiplicans basalibus bulbulis; foliis erectis, extendentibus circiter 18 cm. super terram, 4 mm. latis; pedunculo tubulari, circiter 4. mm in diam.; bractiis spathoidis, teneris et tubularibus; flore circiter 10 cm. longitudine, albo, roseato in jugulo; tubo circiter 3 mm. in diam; segmentis perianthi circiter 18 mm. longitudine, cuspidatis; jugulo circiter 4 mm. in diam.; ovario paulo latiore quam pedunculo, tubulari, nonnunquam paulo ovato; veris folioso sine floribus, post pluviam Aug. vel Sept. florioso sine foliis. S. E. Kansas in prairie atlo et lapidoso.

Type specimen: No. 8177-1 deposited in the University of Kansas herbarium. Collected by W. C. Stevens in Wilson county, Kansas.

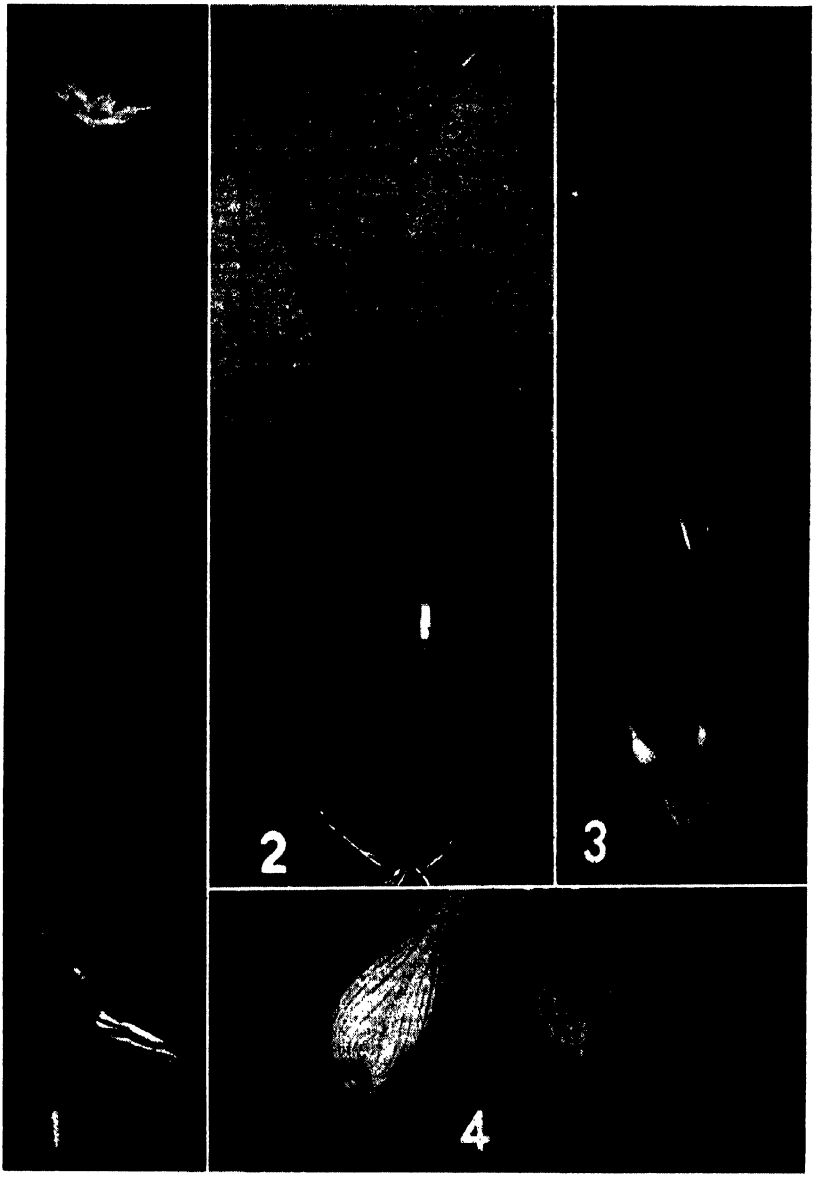
PLATE I

FIG. 1. Photograph of roots, bulb, slender scape and flower.

FIGS. 2 and 3. Photographs of roots, bulb and cluster of grasslike leaves.

FIG. 4. Photograph of vertical section of bulb in its spring condition, with no evidence of a flower.

PLATE I



The Use of Xenyl Mustard Oil as a Reagent for Amines [1]

R. Q. BREWSTER and SISTER AGNES MARIE HORNER, University of Kansas, Lawrence, Kansas.

Only recently has xenylamine (4-amino-diphenyl) become a commercial product; hence our knowledge of its derivatives is limited. A list of thioureas has been prepared by Dains, Andrews[2] and Roberts from xenylamine and various mustard oils. In the present investigation the xenylamine has been converted to xenyl mustard oil which has been found to form easily purified thioureas by addition to primary and secondary amines which serve as additional means of identification.

EXPERIMENTAL PART

Preparation of xenyl mustard oil.

Dixenyl thiourea is first prepared by the action of carbon disulfide upon xenylamine in alcoholic solution.[3] Boiling of the dixenylthiourea with hydrochloric or sulfuric acids gave only a small yield of the xenyl mustard oil. However, three hours boiling of acetic anhydride with the thiourea gave almost complete conversion of the thiourea to xenyl mustard oil and the acetyl derivative of xenyl amine. The xenyl mustard oil is more soluble in ligroin at room temperature than is the acetyl derivative of xenylamine, so these substances may be separated by repeated extraction with the solvent. The xenyl mustard oil crystallizes in long translucent needles which gradually become yellow upon exposure to the air, mp. 60°. Analysis: N = 6.76% and 6.69%. Calc'd for $C_{13}H_9NS$; N = 6.64%.

This separation is not absolutely necessary for use of the xenyl mustard oil as a test reagent for a primary or secondary amine. The amine may be added directly to an alcoholic solution of the mixture of xenyl mustard oil and acetyl xenyl amine; in which case the acetyl xenylamine in no way interferes with production of the thiourea from the xenyl mustard oil and amine. The removal of the acetyl xenyl amine is more easily accomplished after the reaction than prior to it, since the acetyl zenyl amine is more soluble in the usual solvents than are the thioureas produced from the xenyl mustard oil and various amines. A list of thioureas prepared by this method, along with their melting points and analyses, is given in the following table.

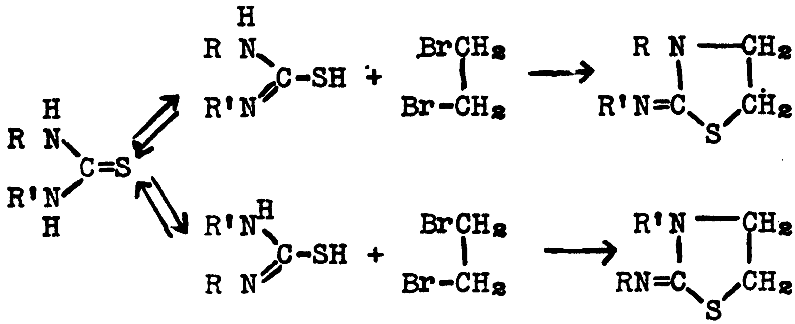
1. Contribution from Department of Chemistry, University of Kansas.
2. Dains, Andrews and Roberts. Univ. of Kansas. Science Bull., 20: 173, (1932).
3. Zimmermann. Ber. d. Deutsche Chem. Ges. 13: 1936, (1880).

AMINE USED.	Thiourea obtained.	M. P., degree.	Formula.	N. calculated percent.	N. found. I.	N. found. II.
Aniline	Xenyl, Phenyl	192	$C_{19}H_{16}N_2S$	9.21	9.52	9.28
o–Toluidine	Xenyl, o–Tolyl	201	$C_{20}H_{18}N_2S$	8.81	8.83	8.88
p–Toluidine	Xenyl, p–Tolyl	192	$C_{20}H_{18}N_2S$	8.81	9.01	9.19
o–Chloroaniline	Xenyl, o–Chlorophenyl	197	$C_{19}H_{15}N_2SCl$	8.27	8.40	8.52
p–Chloroaniline	Xenyl, p–Chlorophenyl	195	$C_{19}H_{15}N_2SCl$	8.27	8.16	8.08
p–Bromoaniline	Xenyl, p–Bromophenyl	196	$C_{19}H_{15}N_2SBr$	7 31	7.33	7.46
o–Anisidine	Xenyl, o–Anisyl	200	$C_{20}H_{18}ON_2S$	8.38	8.38	8.49
p–Phenetidyl	Xenyl, p–Phenetidyl	198	$C_{21}H_{20}ON_2S$	8.05	7.87	7.92
Xenylamine	Xenyl, Xenyl	228	$C_{25}H_{20}N_2S$	7.37	7.42	7.36

The Action of Ethylene Dibromide upon Disubstituted Thioureas [1]

LUDWIG DASHEN and R. Q. BREWSTER, University of Kansas, Lawrence, Kan.

The action of ethylene dibromide upon unsymmetrical disubstituted thioureas may lead to the formation of either one of the two possible thiazolidines or to a mixture of both of them in accordance with the following equation:



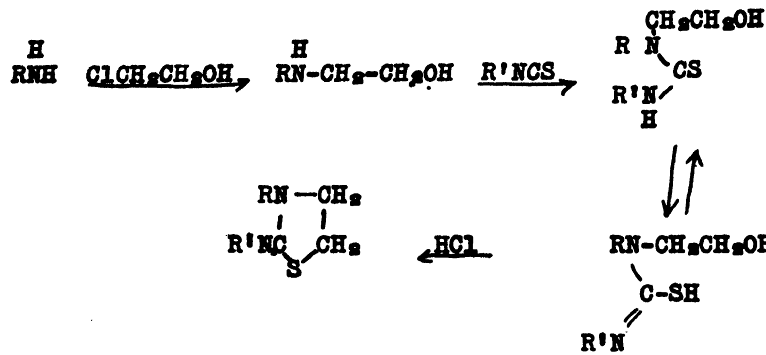
The choice between the two methods of combination obviously depends upon the nature of the two groups R and R′. As the groups are more electro-positive or electro-negative in character the tendency to follow one or the other course almost exclusively becomes very marked and the more positive group is found at position 2 and the more negative group is at position 3. Thus a-ethyl β-phenyl thiourea reacts with ethylene dibromide to give 2-ethyl-3-phenyl thiazolidine.[2] However, if the two groups are very similar in character, such as phenyl and p-tolyl [3] both thiazolidines are produced.

The present study is a comparison of the directing influence in this reaction of the following radicals: phenyl, o-chlorophenyl, p-chlorophenyl, p-bromo-phenyl, o-anisyl and p-phenetidyl. The method of procedure consisted in boiling the disubstituted thiourea with ethylene dibromide in a flask fitted with a reflux condenser, removal of the excess thylene dibromide by steam distillation and extraction of the thiazolidine from the residual mass with hot dilute hydrochloric acid solution. The acid extract is freed from the insoluble portion by filtration and the free thiazolidine precipitated from the cooled acid solution with alkali. Two crystallizations from alcohol or ligroin (bp 90-100°) usually are sufficient for purification. Proof of the identity of the thiazolidine was obtained in each case by synthesis of each of the two possible products as indicated in the scheme on the following page.

In the first step of this synthesis aniline (or other amino compound) is boiled with ethylene chlorohydrin for an hour, the base liberated with alkali and the phenylamino-ethanol separated from any remaining aniline by fractionation at reduced pressure. In alcoholic solution the phenylamino-ethanol readily combines with a mustard oil to give the thiourea which, upon heating

1. Contribution from the Chemical Laboratory of the University of Kansas.
2. Dains et al., J. Amer. Chem. Coc., 47: 1987 (1925).
3. See table by Kharasch and Flenner, J. Amer. Chem. Soc. 54: 674 (1932).

with concentrated hydrochloric acid, loses water with formation of the thiazolidine. In this way thiazolidines may be easily prepared in which the position of each radical is known, and by repeating the synthesis with the radicals interchanged the opposite compound is obtained. Both isomers are therefore available and by the mixed melting point test it is easy to determine which of them has been obtained by the action of ethylene dibromide upon the thiourea.



EXPERIMENTAL PART

In the work here reported seven series of similar experiments were made, only one of which will be described in detail as it is typical of all.

(1) *Preparation of α-Phenyl-β-p-Bromophenyl Thiourea.* A solution of 13.5 g. of phenyl isothiocyanate (0.1 mole) in 100 cc. of 95% ethyl alcohol was slowly added to a solution of 17.2 g. of p-bromo-aniline also in 100 cc. of ethyl alcohol. After standing over night crystallization of the thiourea is practically complete and the crystals are removed by filtration and purified by a recrystallization from alcohol. The α-phenyl-β-p-bromophenyl thiourea melts at 158° and is obtained in almost theoretical yield.

(2) *Action of α-Phenyl-β-p-Bromophenyl Thiourea with Ethylene Dibromide.* In a small flask fitted with a reflux condenser 25 g. of α-phenyl-β-p-bromophenyl thiourea are heated with 40 g. of ethylene dibromide at a temperature of 140° for 2 hours. The excess of ethylene dibromide is then removed by steam distillation and the thiazolidine extracted from any remaining thiourea with hot dilute hydrochloric acid. Addition of alkali to the cooled acid solution precipitates the thiazolidine which is removed and recrystallized from alcohol or ligroin. The thiazolidine melts at 113° and the yield is 15 g. (53% of the theoretical amount). This thiazolidine is shown by the mixed melting point test to be identical with the product obtained in section 6 below and is therefore the 2-phenylimino-3-p-bromophenyl thiazolidine.

(3) *Preparation of Phenylamino-ethanol.* Ninety-three grams of aniline (1.0 mole) and 100 grams of a 40 percent solution of ethylene chlorohydrin were boiled under reflux for six hours. After cooling the mixture was made alkaline with sodium hydroxide solution and the excess of ethylene dibromide and aniline removed by distillation in steam. The residual oil, consisting chiefly

of phenylamino ethanol was dissolved in ether, dried over solid sodium hydroxide and fractionated at reduced pressure; bp. 195-197° at 5 cm.

(4) *Preparation of p-Bromophenyl Isothiocyanate.* The substance was obtained by the method of Dains, Brewster and Olander (Organic Syntheses. Coll. Vol. I p. 437).

(5) *α-Phenyl-α-Ethanol-β-p-Bromophenyl Thiourea.* This thiourea was produced by the addition of an alcoholic solution of 21.4 g. of p-bromophenyl isothiocyanate (0.1 momle) to an adcoholic solution of 13.7 g. (0.1 mole) of phenylamino ethanol. After standing over night the crystals of α-phenyl-α-ethanol-β-p-bromophenyl thiourea were collected on a filter and recrystallized from alcohol. The yield is 23 g. (65%) and the product melts at 131°.

(6) *Conversion of the α Phenyl-α-Ethanol-β-p-Bromophenyl Thiourea to the 2-p-Bromophenylimino-3-Phenyl-Thiazolidine.* A mixture of 15 g. of the thiourea, 25 cc. of concentrated hydrochloric acid and 15 cc. of water was boiled in a flask fitted with a reflux condenser for two hours. The solution was then separated from any undissolved matter by filtration and the thiazolidine precipitated from the cooled filtrate with alkali. After recrystallization from alcohol it melts at 113°. The yield is 9 g. which is 63 percent of the theoretical quantity.

(7) *Preparation of p-Bromophenylamino-Ethanol.* This material was obtained from p-bromoaniline and ethylene chlorohydrin by the method described in section 3 above.

(8) *α-Phenyl-β-p-Bromophenyl-β-Ethanol Thiourea.* This compound was prepared by the reaction of phenyl isothiocyanate with p-bromophenylamino ethanol as outlined in section 5.

(9) *Conversion of α-Phenyl-β-p-Bromophenyl-β-Ethanol Thiourea to 2-Phenylimino-3-p-Bromophenyl Thiazolidine.* This ring closure was accomplished by heating with hydrochloric as stated in section 6. The thiazolidine was precipitated from the acid solution with alkali and recrystallized from alcohol.

(10) *Comparison of the Thiazolidines.* The reaction in section 2 may produce either of the two possible thiazolidines and the course of the reaction was actually determined by comparison of the melting point of the product obtained from the thiourea and ethylene dibromide with the melting points of the thiazolidines of known structure which were synthesized in sections 6 and 9. In this series of experiments α-phenyl-β-p-bromophenyl thiourea was found to combine with ethylene dibromide to give the 2-phenylimino, 3-p-bromophenyl thiazolidine since a mixture of this product and the sample obtained in section 6 showed no depression of the melting point.

The ten operations just described were repeated in six other series of experiments and the results obtained are shown in the following table.

TABLE I

Thiourea heated with ethylene dibromide	Thiazolidine produced
α-Phenyl .... β-p-Bromophenyl	2-Phenylimino 3-p-Bromophenyl
α-Phenyl ...... β-p-Phenetidyl	2-Phenylimino 3-p-Phenetydil[4]
α-Phenyl .. β-o-Anisyl	2-Phenylimino 3-o-Anisyl
α-p-Bromophenyl β-p-Phenetidyl ..	2-p-Bromophenyl 3-p-Phenetidyl
α-p-Bromophenyl β-o-Anisyl	2-p-Bromophenyl 3-o-Anisyl
α-Phenyl .... β-p-Chlorophenyl	2-Phenyl 3-p-Chlorophenyl
α-o-Anisyl .... β-o-Chlorophenyl	2-o-Anisyl 3-o-Chlorophenyl

4. Both isomers were obtained in this case, but the 2-phenylimino-3-p-phenetidyl thiazolidine was produced in the greater quantity.

Some of the compounds prepared in the course of this investigation are not listed in the literature so their melting points (or boiling points) and analyses are recorded in Table II.

TABLE II

COMPOUND.	M. P., degree.	B. p.	Formula.	N. calculated, percent.	N. found, percent.	
p–Phenetidyl Ethanolamine	209	225–25 mm	$C_{10}H_{15}O_2N$	7.73	7.82	7.53
p–Chlorophenyl ethanolamine	83	....	$C_8H_{10}ONCl$	8.16	8.22	8.14
o–Chlorophenyl ethanolamine	....	225–25 mm	$C_8H_{10}ONCl$	8.16	8.20	8.21
2–p–Bromophenylimino. 3–p–Phenetidylthiazolidine	146	....	$C_{19}H_{17}ON_2SBr$	7.42	7.27	7.33
2–p–Bromophenylimino. 3–o–Anisyl thiazolidine	140	....	$C_{16}H_{15}ON_2SBr$	7.71	7.82	7.76
2–Phenylimino. 3–p–Chlorophenyl thiazolidine	110	....	$C_{15}H_{13}N_2SCl$	9.70	9.75	9.61
2–o–Anisylimino. 3–o–Chlorophenyl thiazolidine	146	....	$C_{16}H_{15}ON_2SCl$	8.79	8.69	8.74
2–Phenylimino. 3–p–Phenetidyl thiazolidine	125	....	$C_{17}H_{18}ON_2S$	9.39	9.24	9.20
2–o–Chlorophenylimino. 3–o–Anisyl thiazolidine	130	....	$C_{15}H_{15}ON_2SCl$	8.79	8.70	8.83

These experiments are part of a larger study on the influence of different radicals on the course of various reactions and further results will be published later.

Recent Work on Synthetic Diamonds

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The most successful early work on synthetic diamonds was done by Moissan,[1] a French chemist working in the nineties of the last century. My work on synthetic diamonds was first reported at the academy in 1929[2]. In my original work a crucible of sand or commercial graphite was used for dissolving sugar carbon in melted iron.

For our recent work vegetable compounds were used besides sugar carbon, especially chemically pure gum arabic, since it has a larger number of carbon atoms per molecule. Coal, wood charcoal, coke, etc., were also used.

Solvents used for carbon were copper, silver, lead, nickel-steel with high coefficient of contraction, manganese steel, meteorite iron, tungsten, and blue ground from the South African diamond mines. When tungsten was used, at the completion of the melting, which required about two hours, most of the sugar carbon had been burned into carbon dioxide, due to high melting point for tungsten, which is approximately 3,400° C. It is evident that tungsten would not be a very satisfactory solvent for making diamonds.

Copper used as a solvent, when melted in the furnace, dissolved very little carbon. After the mass was fused and cooled there were a few black particles of carbon present within the copper.

With lead as a solvent no diamonds were obtained. It is possible that, if enough carbon were dissolved in it, and the proper cooling were given, diamonds could be prepared by means of lead. Since lead has a low melting point, it is not necessary to heat the lead as long as iron in the furnace; but, of course, not so much carbon will dissolve at the lower temperature if its solubility in lead is of the same order of magnitude as it is in iron. The mass of lead and dissolved carbon was still quite black, but distinctly lighter in weight. The lightness seems to show that some carbide of lead had been formed, although little research has been done on this subject so far.

When silver was used as a solvent it was found that not much carbon was dissolved and most of this was present in the form of graphite. One advantage with silver is the ready solvent action of nitric acid upon the metal after solidification of the melt.

The blue ground used as a solvent for carbon came from mines from which the natural diamonds are obtained. This blue ground was used in the belief that this might cause more pressure on cooling. It was first pulverized and searched for natural diamonds before using, so that if any diamonds were found after fusion it would be known that they were not there at the beginning of the experiment. After the fused mass was cooled and treated with acids it became almost as hard as concrete. Even this hard mass produced no diamonds.

Ice-cold brine solution has been mostly used for the rapid cooling of the fused mass. For a few tests the furnace with the fused mixture was cooled to room temperature and for others, after fusion, the furnace was wrapped in

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1. Ann. de Chimi et de Phys., 1896.
2. Hershey, J. Willard. Synthetic Diamonds. Trans. Kan. Acad. Sci., 32:52-54, 1929.

asbestos and well insulated to see if cooling very slowly would result in crystallization of larger diamonds. This method of cooling never produced any larger diamonds than these formed by rapid cooling.

As an experiment, solid carbon dioxide was used for cooling. The surface contact between the liquid iron and the dry ice was so poorly made that it was impossible to form any crystal diamonds.

Liquid nitrogen was substituted for the cold brine solution. This did not prove satisfactory, for the reason that the temperature of the liquified gas was so low that the instant the hot molten liquid was dropped into the cooling liquid the liquid nitrogen would change to a gas immediately and form an insulating atmosphere around the iron and thus seriously retard its rate of cooling. It is not the intensity of the low temperature or the coldness of the cooling solution that counts in making diamonds; it is the acceleration of the temperature of the iron downward, or, in other words, it is the rate of change of the temperature of the molten iron that determines the pressure and the inner contraction of the iron and carbon mixture.

FIGURE 1. Synthetic diamond, magnified twenty diameters.

When the white-hot molten iron cools to a red solid it expands, and when cooled from this temperature to the room temperature it contracts. The surface creates the desired internal pressure of approximately 180,000 pounds to the square inch. Because of this great pressure the black sugar carbon changes into crystalline diamond.

The iron of the solidified mass was dissolved in strong acids. The residue, largely composed of amorphous carbon, was digested in hot concentrated hydrochloric acid and potassium chlorate. Then hot sulphuric acid and potassium nitrate, which destroys most of the unchanged carbon, was added. The residue from this treatment was washed for three or four days and then searched for diamonds. Any specimens found were tested.

Some of the tests made for diamonds are as follows: insolubility in hydrofluoric acid; hardness; density; index of refraction; the burning of diamonds in an atmosphere of oxygen. The density is determined by methylene iodide, which has the same density as diamond, 3.51. Diamonds burn in an atmosphere

of oxygen at a temperature of 800° C. almost as easily as you can burn paper with a match. Some of the natural diamonds, as well as the synthetic diamonds, are colored. In such cases they contain some metallic oxides. Many of the synthetic diamonds are black. These are called "borts" and contain some metallic iron. They have the same hardness as genuine diamonds. When borts are burned there will always be some ash, while the transparent diamond leaves no ash.

The electric furnace used is about as large as a two-gallon jar. Synthetic graphite crucibles about the size of a teacup and synthetic graphite electrodes were used. The crucible and electrodes were chemically pure graphite made by the Acheson Graphite Company at Niagara Falls. The mixture was usually heated in the furnace for over an hour from 3,000° to 4,000° C. with a current of 120 volts and 65 amperes.

In some of the experiments as high as six or seven diamonds were obtained, while in many of them none. During the last five years, fifty or more crystals have been made, ranging from those microscopic in size to one $2 \times 1.5 \times 1$ mm., the largest made at McPherson. So far as we have any record, this is the largest synthetic diamond in the world.

The study is being continued with the hope of making larger synthetic diamonds.

Varietal and Seasonal Differences in the Mineral Content of Sweet Clovers[1]

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This study was undertaken in order to determine, first, whether any significant varietal differences exist in the ability of certain sweet clovers to store minerals, and, second, whether variations exist in the mineral content of these clovers.

The study was incidental to a field soil-fertility and variety testing program on clovers conducted in coöperation with the Kansas Agricultural Experiment Station, for whose help and encouragement we wish to express our appreciation.

A number of workers (*1, 2*) have shown that the compositions of sweet clovers respond both to current soil treatment and to treatment the previous fall. Daniel and others (*3, 4, 5*) at the Oklahoma station have reported the composition of a number of legumes and grasses which show the effect of soil composition, fertilizer and rainfall on the calcium, phosphorus, magnesium and nitrogen content. Lush (*6*) studied the composition of pasture grasses and legumes as affected by applications of superphosphate. Holtz (*7*) showed that the type of soil affected the calcium and phosphorus content of red and white clovers in western Washington. Vandecaveye and Bond (*8*) have more recently reported similar studies on the composition of alfalfa.

Very little work seems to have been conducted on various varieties of the same plant species, probably because differences, if they do exist, would not be expected to be significantly great. Since alfalfa and clovers constitute an important source of minerals in animal feeding any variety that would show significant ability to extract these minerals from the soil would have certain obvious advantages.

The field plot upon which these tests were conducted in south central (Harvey county) Kansas was an upland, very fine, sandy loam, well-drained and of average fertility. The plots were seeded to clovers in March, 1935. All the variety test plots received a soil treatment of 300 pounds powdered limestone and 75 pounds rock phosphate per acre, drilled in with the seeding. Eight varieties were included in this program: Commercial Yellow, Commercial White, two strains of Madrid Yellow, Madrid White, Chantland, Madison County and Albotrea.

Four soil-fertility plots, one-tenth acre each, were also seeded to Commercial White clover; one plot with both limestone and phosphate, another with limestone only, a third with phosphate only and the fourth with no soil treatment, to serve as a check.

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1. A contribution from the chemical laboratory of Bethel College, Bethel College, Kan. Financial assistance from the funds of the national youth administration helped defray a part of the cost of this investigation.

SAMPLING AND ANALYSIS

Three series of samples were taken for analysis during the two-year period. The first in June, 1935, when the young plants had reached an average height of 22 inches, the second in October, 1935, just before the first fall frost, and the third in June, 1936, when the second season growth was in full bloom. All the plots were harvested and yields taken at the time of the third sampling. The clovers were not harvested during the first season, but the dead growth was allowed to remain on the ground until the following spring when a part of it was removed by raking.

Areas within the one-tenth-acre plots were selected where soil conditions and growth were as uniform as possible. The plants were cut off at about half an inch above the ground level, air dried without loss of leaves, ground and analyzed.

Analysis was made for calcium, phosphorus and nitrogen. Analyses for magnesium were also made on the samples taken at the time the plots were harvested. Organic matter in the plant material was decomposed by the wet method of Gieseking, Snyder and Getz *(10)*, and aliquot samples taken for calcium, magnesium and phosphorus analysis.

DISCUSSION

It will be noted from Table I that only slight differences in the calcium, phosphorus and nitrogen content were observed and that none of these eight varieties, at least, showed any significant differences in ability to remove minerals from the soil. It is interesting to note, however, that seasonal variations do exist in the mineral content and that each variety shows about the same variation. All but one variety (Madrid White) showed the same seasonal trends. The average for all varieties is given in Table I.

It will be observed that the calcium content reaches a maximum during the fall of the first year and has declined again the following spring to a value even lower than the low of the first year. The average phosphorus content of the eight varieties shows the opposite trend; higher the first spring, lower in the fall and still higher the second season. The nitrogen content parallels the phosphorus content in this respect.

These seasonal variations may be due to variations in rainfall and other climatic factors. Rainfall records for Harvey county (Kansas) show that during the growing season of the first year (1935) precipitation was above normal.

RAINFALL (MARCH TO JUNE)

1935	14.6 inches
1936	5.5 inches
3-year average	9.0 inches

During the second season rainfall was only about sixty percent of normal. No important correlation can be made except that the phosphorus and nitrogen content seem a bit higher during periods of low rainfall and the calcium content is lower during low rainfall periods.

TABLE I.—Seasonal variation in calcium, phosphorus and nitrogen of clover varieties

Variety.	Summer, first year.			Fall, first year.			Summer, second year.		
	% Ca	% P.	% N.	% Ca.	% P.	% N.	% Ca.	% P.	% N.
Commercial Yellow	1.62	0.177	2.65	1.57	0.129	2.23	1.02	0.168	2.44
Madrid Yellow 76	1.38	0.154	2.33	1.89	0.093	1.99	1.09	0.188	2.68
Madrid Yellow 74	1.51	0.145	2.12	1.51	0.109	2.14	1.12	0.206	2.96
Chantland	1.01	0.195	2.60	1.52	0.115	2.14	1.12	0.171	2.89
Madrid White	1.07	0.171	2.68	1.10	0.098	2.14	1.12	0.202	2.61
Madison County	1.23	0.171	3.18	1.77	0.118	2.38	1.03	0.200	3.07
Albotrea	1.11	0.185	2.22	1.61	0.136	2.26	1.11	0.205	2.86
Commercial White	1.16	0.160	2.00	1.74	0.154	2.08	1.27	0.186	2.88
Average	1.25	0.170	2.47	1.59	0.119	2.17	1.11	0.191	2.80

TABLE II.—Effect of soil treatment on seasonal variation in calcium, phosphorus and nitrogen content

(Commercial White)

Soil Treatment.	Summer, first year.			Fall, first year.			Summer, second year.		
	% Ca.	% P.	% N.	% Ca.	% P.	% N.	% Ca.	% P.	% N.
Lime + Phosphate	1.16	0.160	2.00	1.74	0.154	2.08	1.27	0.186	2.88
Check plot	1.18	0.159	2.50	1.53	0.166	2.08	1.15	0.165	2.82
Lime only	1.34	0.156	2.45	1.92	0.106	2.09	1.08	0.200	3.05
Phosphate only	1.25	0.160	1.87	1.90	0.139	2.36	1.12	0.175	2.99

On the soil-fertility plots (Table II) no significant variation in calcium content was observable until the fall of the first year. There the plots that had been treated with lime and phosphate or either alone contain somewhat more calcium than on the plot where no soil treatment was made. The differences may, however, be purely fortuitous. The phosphorus and nitrogen content showed little variation with soil treatment.

When we consider the yields of dry hay obtained from the plots considerable variation is observed. Some of these differences were readily observable in the field. None of the yields were especially high, probably because of the dry weather preceding.

When the yield of hay and the mineral composition of each hay were used to calculate the number of pounds of each mineral extracted from the soil, the results shown in Table III were obtained. Due to the higher yield of hay from Chantland, for example, the amount of lime removed from the soil is almost fifty percent greater than the lowest yielding variety. Almost as great

variations exist for phosphorus pentoxide and magnesia. These differences in yield may, however, be due to differences in ability to resist drought. The spring of 1936, when these yields were taken, was unusually dry.

SUMMARY

Eight sweet clover varieties were grown on uniform field test plots and the plants analyzed for calcium, phosphorus and nitrogen content during three stages of growth. Seasonal variations were observed, but no significant varietal differences could be detected.

TABLE III.—Yields of varieties—summer of second year

Variety.	Height of plant, inches.	Yield.					
		Tons per acre.		Pounds per acre.			
		Green weight.	Dry weight*.	CaO.†	P_2O_5.‡	MgO.	Nitrogen
Commercial Yellow	30	6.85	2.06	59	16	56	100
Madrid Yellow, 27476	33	4,77	1.43	43	12	38	76
Madrid Yellow, 27474	30	5.85	1.76	55	17	46	104
Chantland, 5657	38	8.18	2.46	77	19	74	142
Madrid White	38	7.43	2.23	70	21	65	116
Madison County	26	5.03	1.51	43	14	51	92
Albotrea	30	6.43	1.94	60	18	60	110
Commercial White	34	6.93	2.08	74	18	64	120
Average	32.4	6.43	1.93	60	17	57	107

* Calculated as 30 percent of green weight.
† 300 pounds limestone per acre is equal to 168 pounds CaO.
‡ 75 pounds rock phosphate (28 percent P_2O_5) is equal to 21 pounds P_2O_5.

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An Interpolation Table for Refractive Index-Normality Relationship for Solutions of Hydrochloric Acid and Sodium Hydroxide

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The refractive index of solutions varies with the concentration. A curve may be prepared showing this variation and then if the refractive index of an unknown solution is determined, the concentration may be read from the curve or calculated from the equation of the curve. In a published paper[1] the relationships existing between refractive index and normality for hydrochloric acid up to 4 N and for sodium hydroxide up to 3 N were studied, and equations which show these relationships were formulated.

In order to make an accurate determination with the immersion refractometer, it is necessary that certain precautions be observed. In view of the fact that a 1° C. change in temperature is equivalent to about 0.3 of a scale division or 0.00012 in refractive index for water, it is evident that temperature variations must be small. A variation of ±0.05° C. is equivalent to about 0.015 scale division, which was found to be less than the usual experimental error in reading the instrument. Fortunately, the border line separating dark and light fields in using the refractometer is indistinct and the readings between successive settings are not concordant if the temperature is changing. It is therefore necessary to wait several minutes after the refractometer is immersed in the solution for temperature equilibrium to be reached When a series of measurements are to be taken and the solutions under investigation are placed in the refractometer cups, it was found that paraffined corks effectively minimized an apparent evaporation effect. The mounting in which the dipping prism of the refractometer was fastened was coated with a thin layer of paraffin which prevented corrosive effects when in contact with concentrated hydrochloric acid solutions.

From data, equations for each of the materials at 20.00°, 25.00° and 30.00° C. were determined by substituting normalities and the corresponding refractive indices in the following general equation for a parabola and solving simultaneously:

$$N = B\,(\text{Ref. Ind. Sol'n} - \text{Ref. Ind. Water}) + C\,(\text{Ref. Ind. Sol'n} - \text{Ref. Ind. Water})^2$$

The constants given in Table 1 were chosen as seeming to represent closely the relationship between normality and refractive index for the system studied.

1. E. R. Washburn and A. L. Olsen, J. A. C. S. 54,3212, (1932).

TABLE I

	HCl.		NaOH.	
Temperature, °C.	B.	C.	B.	C.
20.00	119.1	229	89.2	595
25.00	119.0	253	90.7	585
30.00	118.9	267	92.3	550

From these constants an interpolation table has been prepared which greatly facilitates the conversion of refractive index to normality.

TABLE II

Hydrochloric Acid at 20.00° C.

B = 119.1 C = 229

Refractive index.	Normality.	Difference.	Refractive index.	Normality.	Difference.
1.33302	0.000				
		0.119			0.128
1.33402	0.119		1.35402	2.602	
		0.120			0.129
1.33502	0.239		1.35502	2.731	
		0.120			0.129
1.33602	0.359		1.35602	2.860	
		0.121			0.130
1.33702	0.480		1.35702	2.990	
		0.121			0.131
1.33802	0.601		1.35802	3.121	
		0.122			0.130
1.33902	0.723		1.35902	3.251	
		0.122			0.132
1.34002	0.845		1.36002	3.383	
		0.122			0.131
1.34102	0.967		1.36102	3.514	
		0.123			0.133
1.34202	1.090		1.36202	3.647	
		0.124			0.132
1.34302	1.214		1.36302	3.779	
		0.124			0.133
1.34402	1.338		1.36402	3.912	
		0.124			0.134
1.34502	1.462		1.36502	4.046	
		0.125			
1.34602	1.587				
		0.125			
1.34702	1.712				
		0.126			
1.34802	1.838				
		0.126			
1.34902	1.964				
		0.127			
1.35002	2.091				
		0.127			
1.35102	2.218				
		0.128			
1.35202	2.346				
		0.128			
1.35302	2.474				

Hydrochloric Acid at 25.00° C.

B = 119.0 C = 253

Refractive index.	Normality.	Difference.	Refractive index.	Normality.	Difference.
1.33251	0.000				
1.33351	0.119	0.119	1.35351	2.611	0.130
1.33451	0.239	0.120	1.35451	2.740	0.129
1.33551	0.359	0.120	1.35551	2.871	0.131
1.33651	0.480	1.121	1.35651	3.002	0.131
1.33751	0.601	0.121	1.35751	3.133	0.131
1.33851	0.723	0.122	1.35851	3.265	0.132
1.33951	0.845	0.122	1.35951	3.397	0.132
1.34051	0.968	0.123	1.36051	3.530	0.133
1.34151	1.091	0.123	1.36151	3.664	0.134
1.34251	1.215	0.124	1.36251	3.798	0.134
1.34351	1.340	0.125	1.36351	3.932	0.134
1.34451	1.464	0.124	1.36451	4.067	0.135
1.34551	1.590	0.126			
1.34651	1.716	0.126			
1.34751	1.842	0.126			
1.34851	1.969	0.127			
1.34951	2.096	0.127			
1.35051	2.224	0.128			
1.35151	2.352	0.128			
1.35251	2.481	0.129			

Hydrochloric Acid at 30.00° C.

B = 118.9 C = 267

Refractive index.	Normality.	Difference.	Refractive index.	Normality.	Difference.
1.33196	0.000				
		0.119			0.130
1.33296	0.119		1.35296	2.615	
		0.120			0.130
1.33396	0.239		1.35396	2.745	
		0.120			0.131
1.33496	0.359		1.35496	2.876	
		0.121			0.131
1.33596	0.480		1.35596	3.007	
		0.121			0.132
1.33696	0.601		1.35696	3.139	
		0.122			0.133
1.33796	0.723		1.35796	3.272	
		0.122			0.133
1.33896	0.845		1.35896	3.405	
		0.123			0.134
1.33996	0.968		1.35996	3.539	
		0.124			0.134
1.34096	1.092		1.36096	3.673	
		0.124			0.134
1.34196	1.216		1.36196	3.807	
		0.124			0.135
1.34296	1.340		1.36296	3.942	
		0.125			0.136
1.34396	1.465		1.36396	4.078	
		0.126			
1.34496	1.591				
		0.126			
1.34596	1.717				
		0.127			
1.34696	1.844				
		0.127			
1.34796	1.971				
		0.127			
1.34896	2.098				
		0.129			
1.34996	2.227				
		0.128			
1.35096	2.355				
		0.130			
1.35196	2.485				

Sodium Hydroxide at 20.00° C.

B = 89.2 C = 595

Refractive index.	Normality.	Difference.	Refractive index.	Normality.	Difference.
1.33302	0.000				
		0.090			0.114
1.33402	0.090		1.35402	2.136	
		0.091			0.114
1.33502	0.181		1.35502	2.250	
		0.092			0.116
1.33602	0.273		1.35602	2.366	
		0.093			0.118
1.33702	0.366		1.35702	2.484	
		0.095			0.118
1.33802	0.461		1.35802	2.602	
		0.096			0.119
1.33902	0.557		1.35902	2.721	
		0.097			0.121
1.34002	0.654		1.36002	2.842	
		0.098			0.122
1.34102	0.752		1.36102	2.964	
		0 099			0.123
1.34202	0.851		1.36202	3.087	
		0.101			0.125
1.34302	0.952		1.36302	3.212	
		0.101			
1.34402	1.053				
		0.103			
1.34502	1.156				
		0.104			
1.34602	1.260				
		0.105			
1.34702	1.365				
		0.107			
1.34802	1.472				
		0.108			
1.34902	1.580				
		0.108			
1.35002	1.688				
		0.110			
1.35102	1.798				
		0.112			
1.35202	1.910				
		0.112			
1.35302	2.022				

Sodium Hydroxide at 25.00° C.

B = 90.7 C = 585

Refractive index.	Normality.	Difference.	Refractive index.	Normality.	Difference.
1.33251	0.000				
		0.091			0.115
1.33351	0.091		1.35351	2.163	
		0.093			0.116
1.33451	0.184		1.35451	2.279	
		0.093			0.117
1.33551	0.277		1.35551	2.396	
		0.095			0.118
1.33651	0.372		1.35651	2.514	
		0.096			0.119
1.33751	0.468		1.35751	2.633	
		0.097			0.121
1.33851	0.565		1.35851	2.754	
		0.099			0.121
1.33951	0.664		1.35951	2.875	
		0.099			0.123
1.34051	0.763		1.36051	2.998	
		0.101			0.124
1.34151	0.864		1.36151	3.122	
		0.102			0.126
1.34251	0.966		1.36251	3.248	
		0.102			
1.34351	1.068				
		0.105			
1.34451	1.173				
		0.105			
1.34551	1.278				
		0.106			
1.34651	1.384				
		0.108			
1.34751	1.492				
		0.109			
1.34851	1.601				
		0.110			
1.34951	1.711				
		0.111			
1.35051	1.822				
		0.112			
1.35151	1.934				
		0.114			
1.35251	2.048				

Sodium Hydroxide at 30.00° C.

B = 92.3 C = 550

Refractive index.	Normality.	Difference.	Refractive index.	Normality.	Difference.
1.33196	0.000				
1.33296	0.093	0.093	1.35296	2.181	0.115
1.33396	0.187	0.094	1.35396	2.297	0.116
1.33496	0.282	0.095	1.35496	2.414	0.117
1.33596	0.378	0.096	1.35596	2.532	0.118
1.33696	0.475	0.097	1.35696	2.651	0.119
1.33796	0.574	0.099	1.35796	2.772	0.121
1.33896	0.673	0.099	1.35896	2.893	0.121
1.33996	0.774	0.101	1.35996	3.016	0.123
1.34096	0.875	0.101	1.36096	3.139	0.123
1.34196	0.978	0.103	1.36196	3.264	0.125
1.34296	1.082	0.104			
1.34396	1.187	0.105			
1.34496	1.293	0.106			
1.34596	1.400	0.107			
1.34696	1.508	0.108			
1.34796	1.618	0.110			
1.34896	1.728	0.110			
1.34996	1.840	0.112			
1.35096	1.952	0.112			
1.35196	2.066	0.114			

These tables simply reduce the conversion of refractive index to normality into a straight line interpolation relationship, for the intervals have been so chosen as to make the apparent deviations from a straight line a minimum. To make the conversion it is necessary to interpolate the value between which the refractive index falls. We might assume that at 25.00° C. we read a refractive index of 1.35478 for a solution of hydrochloric acid. In Table II for hydrochloric acid at 25.00° C., the given value is found to lie between

Ref. Ind.	Normality
1.35451	2.740

and

1.35551	2.871

and the difference in normality of these values is 0.131, therefore

$$1.35478 - 1.35451 = 0.00027$$
$$27/100 \times 0.131 = 0.035$$

The normality of the assumed value would then be

$$2.740 + 0.035 = 2.775$$

In the case of hydrochloric acid, the greatest difference between the calculated normalites and the actual normalities is ± 0.005. This amounts to an error of $\pm 5.0\%$ with a 0.1 N solution, but to only $\pm 0.5\%$ for a 1.0 N solution or $\pm 0.113\%$ for a 4 N solution. The average difference, however, is only ± 0.002, which would be a percentage error of ± 1.0, ± 0.1 and ± 0.05 for 0.1 N, 1.0 N and 4.0 N, respectively.

The greatest difference between the calculated values and those obtained by analysis for sodium hydroxide is about ± 0.003 in normality. The percentage error would be ± 3, ± 0.3 and ± 0.1 for concentrations of 0.1, 1 and 3 normal, respectively. The average difference is ± 0.001, which, when applied to the three concentrations, would be a percentage error of ± 1, ± 0.1 and ± 0.03. The differences between the calculated and the observed normalities of hydrochloric acid and sodium hydroxide are found to fall within the limits of precision which one would calculate from the slopes of curves plotted from refractive index-normality data and from the accuracy with which one may read the refractometer. One unit in the fifth decimal place in refractive index (0.00001) corresponds to about 0.0012 in normality for hydrochloric acid and to about 0.0009 in normality for sodium hydroxide. The makers of the instrument state that the ordinary worker is able to read scale divisions with a precision of ± 0.2 and with a little practice to a ± 0.1. One tenth of a scale division is equivalent to 0.00004 in refractive index. Therefore

$$
\begin{aligned}
0.2 \text{ in scale reading} &= \pm 0.0096 \text{ in N for HCl} \\
&\ \pm 0.0072 \text{ in N for NaOH} \\
0.1 \text{ in scale reading} &= \pm 0.0048 \text{ in N for HCl} \\
&\ \pm 0.0036 \text{ in N for NaOH}
\end{aligned}
$$

SUMMARY

1. The necessary precautions to be observed in the measurment of refractive index for the precise determination of normality have been presented.

2. An interpolation table for hydrochloric acid from 0 to 4 N and for sodium hydroxide for 0 to 3 N at 20.00°, 25.00° and 30.00° C. has been formulated.

3. An example to illustrate the necessary calculations involved in the conversion of refractive index into normality has been given.

4. The limits of precision with which one may expect to determine the concentrations of solutions by this method are presented.

Humidity and Specific Gravity of Soil Particles[1]

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Considerable interest has recently been evinced in the mineralogical composition of soils. Perkins and King (*1*), (*2*), have studied soil minerals by separating them according to particle size, and fractionating the separates according to specific gravity. The separations according to particle size were made by sedimentation in water. The separates were then fractionated according to specific gravity by suspending the soil particles in carbon tetrachloride-bromoform solutions of the desired specific gravity, and then centrifuged. Separation on a basis of particle size can be accomplished with a considerable degree of accuracy as the variation of the particle size between different separations, as made, is approximately 1,000 percent, while the variation in specific gravity of the individual particles is less than 25 percent. Before fractionation, the soil separates were moistened with carbon tetrachloride and subjected to a high vacuum. Thus any air adsorbed by the particles was removed and replaced by carbon tetrachloride. These studies of particle size and their specific gravity have been made on the noncolloidal parts of several Kansas soils. At present similar studies are proceeding on soils obtained from the soil fertility plots at New Jersey, Ohio, and Pennsylvania.

The separations having been made by water suspensions are, of course, made under conditions of water saturation. The fractionations, having been made in carbon tetrachloride-bromoform solutions, might be affected by a film of water on the soil minerals. The purpose of this investigation was to determine whether sufficient water is adsorbed and held by soil particles to affect materially their specific gravity. To ascertain this the percentage of soil particles falling into several specific gravity groups was determined. It seemed possible that certain soil minerals might change their apparent specific gravity by water adsorption while others would not. This differentiation has not been investigated, but is considered as a possible means of making future mineral separations.

Soil separates were obtained from Derby soil so that their average diameters were approximately 0.056, 0.028, 0.012, and 0.006 mm. These separates were placed in desiccators containing 95 percent, 52 percent, 35 percent and 0 percent sulfuric acid until constant weight was obtained. Separates freshly dried at 110° were also used. These samples gained various amounts of water on storage in atmospheres of different humidity. The percentages of weight gained at equilibrium compared with separates freshly dried at 110° are given in Table I. It is evident that the smaller the particle and the more humid the air in which it is stored, the greater is the amount of adsorbed water. The D separates stored over 35.26 percent H_2SO_4 gained 1.59 percent in weight, while the A separates stored over 95 percent H_2SO_4 gained only 0.01 percent in weight. The adsorbed film of water if held sufficiently tenaciously in a carbon tetrachloride-bromoform solution might affect the specific gravity of the particles.

1. Contribution No. 229, Department of Chemistry, Kansas State College.

From the data recorded in Table II it may be noted that there seems to be a tendency for increased water adsorption by the soil to decrease the percentage of separates whose specific gravity is less than 2 and in the fraction whose specific gravity is between 2.0 and 2.3. These data are not conclusive. It should be noted that as water adsorption increased, the percentage of material in the 2.3-2.5 fraction decidedly increased at the expense of the 2.5 fraction. This is logical as the soil minerals with a specific gravity of over 2.5 would have their apparent specific gravity decreased by a film of adsorbed water. The 2.3-2.5 fraction increased from 2.42 percent to 5.52 percent in the case of the coarse separates and from 14.18 percent to 29.78 percent in the case of the finer separates. This is a significant difference and indicates that accurate separations can be made only by considering humidity and adsorbed water. From the values recorded in the last column of Table II it may be noted that in no case was 100 percent of the separate recovered as fractions. The percentage lost seems high for a quantitative procedure, but the loss occurred through penetration of fine particles into the filter paper and other unavoidable mechanical phenomena.

CONCLUSIONS

Sufficient water may be adsorbed on soil particles to affect appreciably the percentage of the soil appearing in different specific gravity fractions.

REFERENCES

(1) PERKINS, A. T., and H. H. KING. Base Exchange in Soils. Trans. Kans. Acad. Sci. 38: 163-170 (1935).

(2) ——— Base Exchange in Soil Separates and Soil Fractions (Sand and Silt). Soil Science 42: 323-326 (1936).

TABLE I.—Percentage of water adsorbed by soil separates stored over sulfuric acid

Concentration of H_2SO_4, percent	95.00	52.33	35.26
Water vapor pressure, mm. Hg	....	6.01	15.7
Separate A 0.056 mm. diam	0.01	0.18	0.33
Separate B 0.028 mm. diam	0.02	0.19	0.33
Separate C 0.012 mm. diam	0.01	0.29	0.85
Separate D 0.006 mm. diam	0.04	0.89	1.59

TABLE II.—Effect of adsorbed water on soil fractionation and percentage in separate

Vapor Pressure Stored in; mm. Mercury.		Specific gravity limits.			
	—2.0 percent.	2.0—2.3 percent.	2.3—2.5 percent.	2.5 + percent.	Total* percent.
Separate A. Average Diameter 0.056 mm.					
Oven-dried	0.12	0.30	2.42	96.76	99.60
Zero	0.05	0.03	3.23	95.10	98.41
6.01	0.12	0.31	3.20	95.10	98.73
15.70	0.05	0.21	5.52	95.18	99.64
Separate B. Average Diameter 0.028 mm.					
Oven-dried	0.38	0.81	2.60	94.69	98.48
Zero	0.15	1.02	4.27	93.43	98.87
6.01	0.14	0.69	3.15	94.80	98.78
15.70	0.07	0.68	5.20	92.96	98.91
Separate C. Average Diameter 0.012 mm.					
Oven-dried	0.42	2.32	3.12	90.67	96.53
Zero	0.08	1.90	5.58	89.84	97.40
6.01	0.01	1.90	7.65	87.37	96.93
15.70	0.00	1.65	9.50	84.53	95.60
Separate D. Average Diameter 0.006 mm.					
Oven-dried	0.00	1.02	14.18	79.17	94.37
Zero	0.01	2.85	24.14	70.32	97.42
6.01	0.00	0.71	26.46	70.83	98.00
15.70	0.00	0.41	29.78	66.25	96.44

* Some material unavoidably lost in handling.

Comparative Analyses of Molasses[1]

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Molasses has long been sold on the basis of a Baumé test, but stockmen ordinarily purchased it primarily for its energy value or sugar content. Few of the thousands of references available on molasses and its analysis compare the Baumé value of a molasses and its sugar content. In addition to these two items, investigators of molasses have reported viscosity; ash, potassium, calcium, copper, iron, and sulfate content; source as cane, beet, or other; organic nonsugar content; nitrogen; protein; protein decomposition products; gums; waxes; vitamins; and certain other miscellaneous items such as color and fermentability.

The object of this investigation was to gather information that would be of value to the feeder in selecting molasses. Little is actually known of the digestibility of molasses. The sugar is ordinarily considered digestible, but the feeding value of the organic nonsugars is uncertain. These organic nonsugar components differ in various samples and it is impossible to make an accurate statement that is generally applicable regarding them. Molasses is a by-product of sugar refining and, as a by-product, its composition varies. As the sugar in molasses sells for approximately one tenth as much as it would sell for if it were refined, there is an effort on the part of the manufacturer to remove as much sugar as possible from molasses. The composition of molasses varies with the efficiency of the individual manufacturer, the methods used in the refinery, the crop from which the sugar is made, the climatic conditions under which the crop is grown, the progress of the sugar season, and many other factors. Among feeders there is a belief that the Baumé and/or the viscosity is a measure of the sugar content of the molasses and its feeding value.

In the present investigation the sugar content of samples of molasses has been tabulated together with the moisture, sulfated ash, organic nonsugar, the Baumé and viscosity figures. Forty-two samples of molasses were investigated. These were taken from the market by the feeding-stuff inspectors of the Kansas State Board of Agriculture, and represent molasses as sold in Kansas. The sugar was determined by copper reduction, after inversion by acid hydrolysis, as given in the A. O. A. C. methods (1935), under sugar and sugar products in paragraphs 28, 37, 39; moisture in paragraph 4; sulfated ash as in paragraph 10; Baumé in paragraph 5; organic nonsugar by adding the sugar content, moisture and ⅘ of the sulfated ash and substracting this figure from 100; and a measure of viscosity by determining the relative flow time from a Saybolt viscosimeter that permitted a 46.7 percent sucrose solution to flow out in ten seconds. All viscosity determinations were made at 25° C.

The data collected are presented in Table I with the samples arranged according to sugar content. For purposes of easy comparisons the same data are given in Table II arranged according to moisture content.

It should be noted that the sugar content of different samples varied from

1. Contribution No. 227. Department of Chemistry, Agricultural Experiment Station, in coöperation with the Kansas State Board of Agriculture.

44.40 percent to 63.60 percent, while the organic nonsugar content varied from 8.38 percent to 21.32 percent and that little relation can be established between any of the analyses.

TABLE I.—Analyses of molasses arranged according to sugar content

Lab. No.	*Sugar*	*Moisture*	*Sulfated ash*	*Organic nonsugars*	*Baumé*	*Flow time rel. vis.*
3847	44.40	34.01	9.76	15.08	43.1	16:41
4498	45.72	28.33	13.81	16.74	42.4	10:10
4593	46.12	31.89	11.30	14.46	39.9	4:30
4594	47.12	29.79	16.93	11.80	42.9	2:59
4796	47.54	27.31	12.68	16.70	42.4	11:34
4025	48.10	25.53	13.21	17.56	42.3	5:58
4026	48.60	25.70	13.40	16.77	....	....
3899	48.80	26.03	11.42	17.56	41.7	4:52
3843	48.96	25.24	11.48	18.15	44.3	16:27
3903	49.00	26.49	11.23	17.02	41.7	9:56
4681	49.08	28.61	14.41	12.70	43.2	4:35
3810	49.10	25.25	12.35	17.42	45.1	27:12
3806	49.30	26.76	12.61	15.53	42.9	10:54
3811	49.30	26.70	12.60	15.60	43.4	14:12
3954	50.10	26.53	10.56	16.33	42.8	18:02
3808	50.20	27.17	12.53	14.28	43.5	12:57
3815	50.20	25.40	11.57	16.69	42.5	10:30
3809	50.30	24.04	11.85	17.76	45.2	26:30
3813	50.30	26.02	10.52	16.67	44.3	11:44
3812	50.40	25.84	10.63	16.67	42.5	12:21
3814	50.40	25.37	11.57	16.52	43.1	13:26
3902	50.40	23.93	10.59	18.61	43.7	21:00
4271	50.40	26.82	14.85	12.88	43.6	4:27
3807	50.50	24.05	11.83	17.56	45.5	28:38
3845	50.50	28.07	10.81	14.22	41.6	4:30
3844	50.68	25.69	10.55	16.60	43.0	19:37
4494	51.22	26.39	9.96	15.75	42.1	17:35
3905	51.90	28.31	11.50	12.12	41.0	3:30
3904	52.30	28.32	11.72	11.57	41.3	3:21
3900	52.40	23.90	10.66	16.69	45.0	52:00
3901	53.00	24.07	8.62	17.18	42.9	18:52
3932	53.20	26.42	11.27	12.87	43.6	8:25
3564	53.40	27.23	13.15	10.60	42.1	4:50
4197	53.40	.....	.....	.....	45.3	150:00
4173	54.10	26.41	11.72	11.68	42.7	3:50
3841	54.20	19.68	11.37	18.54	46.2	146:10
3842	54.20	19.22	11.25	19.08	46.2	108:21
3955	54.90	23.09	6.64	17.58	42.5	6:18
4482	55.16	27.45	13.51	8.38	41.9	2:55
3447	55.50	21.43	2.63	21.32	43.1	16:41
4590	56.22	23.26	16.02	9.84	45.5	24:33
4272	63.60	22.60	6.03	9.78	43.2	22:00

TABLE II.—Analyses of molasses arranged according to moisture content

Lab. No.	*Moisture*	*Baumé*	*Sugar*	*Organic nonsugars*	*Sulfated ash*	*Flow time rel. vis.*
3842	19.22	46.2	54.20	19.08	11.25	108:21
3841	19.68	46.2	54.20	18.54	11.37	146:10
3447	21.43	43.1	55.50	21.32	2.63	16:41
4272	22.60	43.2	63.60	9.78	6.03	22:00
3955	23.09	42.5	54.90	17.58	6.64	6:18
4590	23.26	45.5	56.22	9.84	16.02	24:33
3900	23.90	45.0	52.40	16.69	10.66	52:00
3902	23.93	43.7	50.40	18.61	10.59	21:00
3809	24.04	45.2	50.30	17.76	11.85	26:30
3807	24.05	45.5	50.50	17.56	11.83	28:38
3901	24.07	42.9	53.00	17.18	8.62	18:52
3842	25.24	44.3	48.96	18.15	11.48	16:27
3810	25.25	45.1	49.10	17.42	12.35	27:12
3814	25.37	42.1	50.40	16.52	11.57	13:26
3815	25.40	42.5	50.20	16.69	11.57	10:30
4025	25.53	42.3	48.10	17.56	13.21	5:58
3844	25.69	43.0	50.68	16.60	10.55	19:37
4026	25.70	....	48.60	16.77	13.50	.....
3812	25.84	42.5	50.40	16.67	10.63	12:21
3813	26.02	44.3	50.30	16.67	10.52	11:44
3899	26.03	41.7	48.80	17.56	11.42	4:52
4494	26.39	42.1	51.22	15.75	9.96	17:35
4173	26.41	42.7	54.10	11.68	11.72	3:50
3932	26.42	43.0	53.20	12.87	11.27	8:25
3903	26.49	41.7	49.00	17.02	11.23	9:56
3954	26.53	42.8	50.10	16.33	10.56	18:02
3811	26.70	43.4	49.30	15.60	12.60	14:12
3806	26.76	42.9	49.30	15.53	12.61	10:54
4271	26.82	43.6	50.40	12.88	14.85	4:27
3808	27.17	43.5	50.20	14.28	12.53	12:57
3564	27.23	42.1	53.40	10.60	13.15	4:50
4796	27.31	42.4	47.54	16.70	12.68	11:34
4482	27.45	41.9	55.16	8.38	13.51	2:55
3845	28.07	41.6	50.50	14.22	10.81	4:30
3905	48.31	41.0	51.90	12.12	11.50	3:30
3904	28.32	41.3	52.30	11.57	11.72	3:21
4493	28.33	39.9	46.12	14.46	11.30	4:30
4681	28.61	43.2	49.08	12.70	14.41	4:35
4594	29.79	42.9	47.12	11.80	16.93	2:59
4593	31.89	39.9	46.12	14.46	11.30	4:30
4847	34.01	43.1	44.40	15.08	9.76	16:41
4197	.....	45.3	53.4	.....	.....	150:00

CONCLUSIONS

1. The Baumé value of a molasses does not measure its sugar content.

2. There is no relation between the sugar content of molasses and its content of moisture, ash, or organic nonsugar, or its viscosity.

3. Since the sugar in molasses is known to be digestible and approximately 85 percent of the energy value of molasses is in the sugar, it would seem that the best criterion of the feeding value of a molasses would be its sugar content.

Differential Resistance to Chinch-bug Attack in Certain Strains of Wheat

By ELMER T. JONES, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture

INTRODUCTION

An unusual opportunity was afforded at Manhattan, Kan., during the spring of 1935, to make observations on the reaction of several hundred strains of wheat to chinch-bug attack. A nursery of many varieties and selections of winter wheat,[1] planted as an experiment in an investigation of Hessian-fly resistance, conducted jointly by the Bureaus of Entomology and Plant Quarantine and Plant Industry of the United States Department of Agriculture and the Kansas State Agricultural Experiment Station, became heavily infested with chinch bugs. Severe damage to a portion of the nursery resulted. To evaluate this damage so that agronomic and Hessian-fly records could be correctly interpreted, observations on the progress of injury were made.

Since the observations on stunted plants and on differential injury to strains of wheat by chinch bugs and drought was incidental to the chief purpose of the experiment, the data are not so exhaustive or complete as might be desired. Nevertheless it is believed that they are a fairly reliable preliminary measure of the reaction of these various strains to chinch-bug attack.

INFESTATION

In the fall of 1934 large numbers of chinch bugs from an adjoining field of sorghum migrated into the aforementioned test plots of approximately 600 strains of wheat and overwintered among the wheat plants. Healthy nymphs of all stages from the second instar to the last instar were found about the plants as late as December 6, indicating that feeding had continued late into the fall. Very little rain fell during the period of infestation. During the first four months of 1935 the total rainfall at Manhattan was only 2.9 inches. The dry, open winter and early spring favored development and feeding of the chinch bugs. They began feeding early in March and continued to feed until destroyed by heavy rains in May.

INJURY TO WHEAT

Injury was first observed about March 20. It became progressively worse, and in April and May differences in degree of injury to various strains were quite noticeable. Leaves of severely injured strains became discolored and curled at the edges and the plants assumed a sickly appearance characteristic of severe chinch-bug injury.

On May 10 a duplicate series of 168 strains of winter wheat growing in the area of greatest infestation was rated according to severity of injury, but counts to determine the percent of infestation and the number of bugs present on each row were not made. General observations indicated that relatively

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1. The winter-wheat nurseries at Manhattan, Kan., are grown in coöperation with the Division of Cereal Crops and Diseases of the Bureau of Plant Industry, U. S. Department of Agriculture, and the Kansas State Agricultural Experiment Station.

few bugs were found on plants of strains classed as lightly injured, while on plants of strains rated as moderately or severely injured infestation was comparatively heavy, although these strains had equal exposure and similar opportunity for infestation within the replicates. The plants of the first replicate received the initial infestation and were more severely affected. Shortly after these observations were made, heavy rains fell, and by May 21 few bugs survived. Subsequent infestation was very light.

STUNTING OF INFESTED PLANTS

All the plants in many of the rows rated as injured on May 10 were observed, after heading, to be stunted to half the height of normal plants. Uninjured plants, in many cases growing beside rows of stunted plants which had been severely injured by chinch bugs and drought, grew to normal height. Agronomists, entomologists and plant pathologists who examined the nursery could not recall a similar case in which some strains of wheat were uniformly stunted and others were not.

Occurrence of uniformly stunted plants in rows which had been heavily infested with chinch bugs was general over the area of infestation. No stunted plants were found in the uninfested or lightly infested section of the nursery distant from the points of invasion.

On June 12 the varieties and selections were rated, on the basis of normal and stunted plants, by the writer and by Dr. John H. Parker, plant geneticist of the Kansas Agricultural Experiment Station. Later Dr. R. H. Painter, entomologist of the same institution, rated them according to degree of resistance and susceptibility to injury.

RESULTS AND DISCUSSION

Summarized results based on these ratings are shown in the accompanying table. In analyzing the data, records of May 10 should be given greatest weight, as the chinch bugs were not present in appreciable numbers when the other examinations were made. Consideration should also be given the fact that infestation was not uniform throughout the plots, although one complete replication and a considerable number of rows in the second replication had been uniformly infested by overwintering chinch bugs. The observed differences were not related to winter injury, noticeable lack of vigor, or thin stands.

The data shown are based on observations of duplicate rows, each occurring at a different place in the nursery. In this table strains are arranged in ascending order of severity of injury.

The symbols used in the table are as follows:

S = Severe injury.
M = Moderate injury.
St. = Stunted plants, severe injury.
L = Light injury, either by chinch bugs or drought.
O = No apparent injury.
Mixed = Severely injured, stunted plants and normal plants intermixed.

Plants in all strains not classed as stunted or mixed are of normal height.

RESISTANCE TO CHINCH-BUG INJURY IN WHEAT, MANHATTAN, KAN., 1935

Row No.	VARIETY, CROSS OR SELECTION.	Degree of injury.			
		May 10, 1935.		June 12, 1935.	
		Most injured replicate.	Least injured replicate.	Most injured replicate.	Least injured replicate
	UNINJURED				
589	Utac selection	O	O	O	O
592	Garfield	O	O	O	O
478	Gipsy selection	L	O	O	O
483	Harvest Queen × Kawvale (5 selections)	L	O	O	O
430	Harvest Queen C. I. 6199	L	O	O	O
515	Regal C. I. 7364	L	O	O	O
584	Alstroum (spelt)	L	O	O	O
507	Cooperatorka C. I. 8861	L	O	O	O
582	Dawson selection	L	O	O	O
506	Iowin C. I. 10019	L	O	O	O
518	Kanred × Hard Fed. selection	L	O	O	O
508	Kruse, Neb., 1058	L	O	O	O
510	Marion, Kan., 525	L	O	O	O
511	Marion selection	L	O	O	O
581	Mediterranean selection	L	O	O	O
428	Mediterranean C. I. 11567	L	O	O	O
585	Red Winter Spelt	L	O	O	O
519	Wisconsin selection, Kan., 2125	L	O	O	O
488	Bald Rock C. I. 11538	L	L	O	O
562	Fultz (2 selections)	L	L	O	O
491	Fulhard selection	L	L	O	O
544	Fulhard × Oro	L	L	O	O
523	Harvest Queen × Shephard	L	L	O	O
505	Iobred selection	L	L	O	O
447	Illinois Progeny No. 2, C. I. 11537	L	L	O	O
446	Purdue No. 1, C. I. 11380	L	L	O	O
432	Purkof C. I. 8381	L	L	O	O
516	Shepherd C. I. 6163	L	L	O	O
546	Fulhard × Oro (2 strains)	L	L	O	O
580	Michigan Wonder selection	L	L	O	O
481	Mundszentpusstai No. 403 C. I. 10191	L	L	O	O
	INJURED				
514	Olmitz, Kan., 528	L	L	L	L
512	Michigan Amber selection C. I. 5620	L	O	M	M
524	Trumbull C. I. 5657	L	L	Mixed	Mixed
547	Fulhard × Illini Chief selection	L	O	St.	O
433	Purple Straw C. I. 1915	L	L	St.	M
429	Currell C. I. 3326	L	L	St.	St.
171	Early Blackhull selection	M	L	St.	M
185	Kanred × Hard Fed. Kan., 2671	L	L	St.	St.
532	Kawvale × C. I. 8034 (3 selections)	M	O	St.	O
533	Kawvale × Tenmarq selection	M	L	St.	L
591	Carthage	M	L	St.	St.

RESISTANCE TO CHINCH-BUG INJURY IN WHEAT, MANHATTAN, KAN., 1935

Row No.	VARIETY, CROSS OR SELECTION.	Degree of injury. May 10, 1935. Most injured replicate.	Degree of injury. May 10, 1935. Least injured replicate.	Degree of injury. June 12, 1935. Most injured replicate.	Degree of injury. June 12, 1935. Least injured replicate.
	INJURED				
552	Early Blackhull (4 rows)	M	L	M	L
457	Fulhard Kan., 2594 (4 rows)	M	L	M	M
542	Fulhard × Oro selection	M	L	St.	S
541	Fulhard × Tenmarq	M	L	St.	L
578	Fulcaster selection	M	L	St.	L
573	Honor selection	M	L	St.	S
522	Illini Chief × Marquis selection	M	L	St.	St.
557	Illini Chief selection 223415 (4 rows)	M	L	Mixed	Mixed
569	Kanred selection	M	L	L	O
524	Kanred × Blackhull	M	L	S	S
490	Lincalel M. A. (Argentine)	M	L	St.	M
563	Mammoth Red selection	M	L	St.	S
567	Mediterranean selection	M	L	St.	S
568	Michigan Wonder selection	M	L	M	L
566	Minturki selection	M	L	St.	S
513	Nebraska No. 28 selection	M	L	St.	St.
577	Rudy selection	M	L	St.	L
574	St. Genevieve selection	M	L	St.	S
588	Sevier selection	M	L	L	L
565	Superhard Blackhull selection	M	L	St.	L
575	Ziegler's Choice selection	M	L	St.	St.
485	Tenmarq × Kawvale selection	S	O	Mixed	O
559	Currell selection	S	L	M	L
479	Denton C. I. 8265	S	L	St.	M
421	Forward C. I. 6691	S	L	St.	M
551	Fulhard × Illini Chief (4 selections)	S	L	St.	S
561	Fulcaster selection	S	L	St.	L
501	Fulcaster selection (Shaffer)	S	L	St.	St.
423	Fulhio C. I. 6999	S	L	Mixed	Mixed
593	Garber	S	L	St.	St.
570	Illini Chief (2 selections)	S	L	St.	Mixed
504	Imperial Amber, Kan., 2588	S	L	St.	S
527	Kawvale × Blackhull selection	S	L	St.	M
536	Kawvale × Tenmarq (2 strains)	S	L	St.	O
458	Minturki (Illinois)	S	L	S	M
422	Nittany C. I. 6962	S	L	St.	O
560	Poole selection	S	L	St.	L
487	Sutton C. I. 10053	S	L	St.	St.
173	Superhard Blackhull, Kan., 470	S	L	St.	M
454	Tenmarq, Kan., 514 (6 rows)	S	L	St.	M
517	Turkish Amber, Colo., 485	S	L	St.	S
540	Fulhard × Kawvale selection	S	M	St.	St.
492	Pico No. 137 D. G. 11441	S	M	St.	—
486	Fulcaster × Marquis selection	S	M	St.	O

RESISTANCE TO CHINCH-BUG INJURY IN WHEAT, MANHATTAN, KAN., 1935

Row No.	Variety, Cross or Selection.	Degree of injury.			
		May 10, 1935.		June 12, 1935.	
		Most injured replicate.	Least injured replicate.	Most injured replicate.	Least injured replicate.
	INJURED				
594	Black Winter Emmer	S	M	L	S
495	Clavate, Colo., 575	S	M	St.	St.
480	Dietz C. I. 1981	S	M	St.	Mixed
538	Fulhard × Kawvale (2 selections)	S	M	St.	St.
499	French R. M. 1510	S	M	St.	S
497	French R. M. 193	S	M	St.	M
498	French R. M. 67	S	M	St.	O
502	Genessee Giant	S	M	St.	S
124	Kanred selection	S	M	St.	St.
441	Kawvale C. I. 8180	S	M	Mixed	Mixed
526	Kawvale × Blackhull (3 selections)	S	M	St.	L
426	Leap C. I. 6958	S	M	St.	O
468	Malakof, Kan., 170	S	M	St.	S
439	Minturki C. I. 6155	S	M	Mixed	Mixed
460	Minturki × Blackhull	S	M	St.	Mixed
462	Mediterranean selection C. I. 10085	S	M	St.	M
126	Oro selection, Kan., 132	S	M	St.	M
427	Poole C. I. 3488	S	M	St.	Mixed
465	Poole selection, Ohio 13384	S	M	St.	S
474	Schenck's White Mediterranean C. I. 10023	S	M	St.	St.
461	Winter King C. I. 3546	S	M	St.	St.
520	Yogo C. I. 8033	S	M	St.	St.
482	Gasta C. I. 11398	S	S	St.	St.
477	Early Red May, Ga., 182	S	S	St.	St.
125	Fulhard × Oro (2 selections)	S	S	St.	O
435	Fulcaster C. I. 6471	S	S	St.	Mixed
455	Kawvale, Kans., 2593 (6 rows)	S	S	St.	Mixed
127	Oro selection, Kan., 128	S	S	St.	St.
425	Red Hart C. I. 11654	S	S	M	M
431	Red Rock C. I. 6951	S	S	M	M
464	Texas selection, Kan., 8184	S	S	St.	St.
	INJURED BUT RECOVERED				
470	Mammoth Red C. I. 2008	M	O	O	O
564	Harvest Queen selection	M	L	O	O
503	Hussar C. I. 4843	M	L	O	O
476	Berkeley Rock C. I. 6835	M	L	O	O
521	P 1066 × Burbank C. I. 10087	M	L	O	O
466	Kanred × Red Rock selection	M	L	O	O
471	Valley C. I. 5923	M	L	O	O
475	Fultz C. I. 1923	M	L	O	O
572	Nebraska No. 60 selection	M	L	O	O
170	Red Winter selection	M	L	O	O
472	Red Wave C. I. 3500	M	L	O	O

RESISTANCE TO CHINCH-BUG INJURY IN WHEAT, MANHATTAN, KAN., 1935

Row No.	Variety, Cross or Selection.	Degree of injury. May 10, 1935. Most injured replicate.	Degree of injury. May 10, 1935. Least injured replicate.	Degree of injury. June 12, 1935. Most injured replicate.	Degree of injury. June 12, 1935. Least injured replicate.
	INJURED BUT RECOVERED				
175	Superhard Blackhull selection	M	L	O	O
450	Valprize C. I. 11539	M	L	O	O
579	Prohibition selection	M	L	O	O
500	French R. M. 1385	M	M	O	O
576	Dawson selection	M	M	O	O
489	Guatrache M. A. (Argentine)	M	M	O	O
509	Lutescens, Kan., 491	S	O	O	O
473	Fultz selection C. I. 5308-1-1-1	S	L	O	O
444	Gladden C. I. 5644	S	L	O	O
438	Minhardi C. I. 5149	S	L	O	O
443	Nabob C. I. 8869	S	L	O	O
434	Rudy C. I. 5656	S	L	O	O
463	Nebraska No. 60 C. I. 6250	S	L	O	O
452	Turkey, Kan., 570 (4 rows)	S	L	O	O
442	Wisconsin Ped. No. 2 C. I. 6683	S	L	O	O
440	Kharkoff C. I. 1442	S	L	O	O
496	French R. M. 19	S	M	O	O
453	Illini Chief selection 193287 (4 rows)	S	M	O	O
445	Michigan Amber C. I. 5620	S	M	O	O
469	Stoner, Ga., 109	S	M	O	O
459	Minturki, Kan., 2464	S	M	O	O
436	Honor C. I. 6161	S	S	O	O
437	Junior No. 6 C. I. 6971	S	S	O	O

The group of thirty-seven strains listed as uninjured or lightly injured suggests the possibility of resistance to chinch bugs and includes strains of which further tests would be desirable. As most of these strains had been exposed to severe infestation, the light injury recorded is thought to be due to drought rather than to chinch bugs. Plants of ninety-seven strains classed as injured are definitely susceptible under the conditions of this test, as are the thirty-four strains which recovered completely from moderate and severe injury after the bugs had disappeared. It may be noted from the table and figure 1 that some strains were mixed for stunted and normal plants. These may represent segregating lines.

The strains of wheat showing the greatest resistence to injury by drought and chinch bugs are soft wheats, although Regal (C. I. 7634), a wheat of Crimean origin, is a noteworthy exception.

One strain of Fulhard and three Fulhard hybrid selections were lightly infested and may be resistant. Kawvale and Oro are shown in these tests to be extremely susceptible. Kawvale hybrids, except for selections of Harvest Queen × Kawvale, occur among the most severely injured strains while Ful-

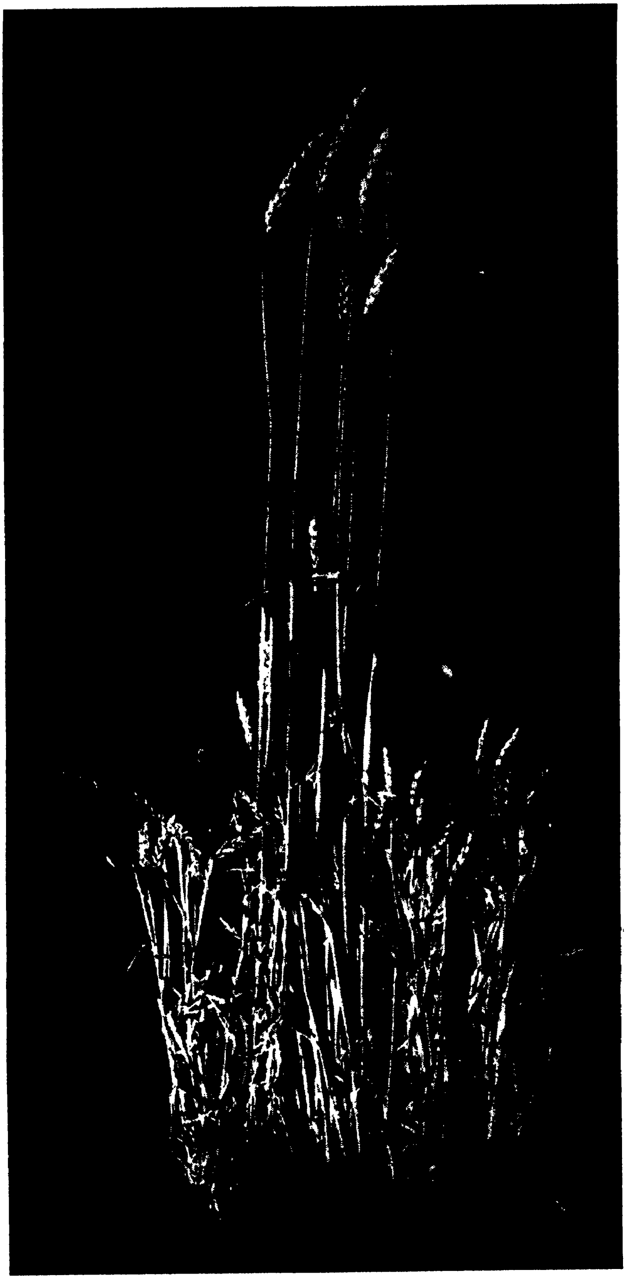

FIGURE 1. Typical stunted wheat plants with a single normal wheat plant.

hard × Oro selections are found at both extremes. Two selections of Harvest Queen and five selections of Harvest Queen × Kawvale appear in the lightly injured group. This reaction and the similar ones occurring in the case of Fulhard Sel. 491 and three selections of Fulhard × Oro afford additional evidence that resistance to chinch-bug injury may be hereditary.

In addition to the strains listed in the table, a large number of F_6 selections of Kanred crossed with Illini Chief, Honor, Dawson, St. Genevieve, Ziegler's Choice and F_7 selections from Illini Chief × Blackhull were similarly affected by overwintering chinch bugs. Incomplete records of injury to these strains taken on May 21, after heading, show the presence of tall and short plants in the same injured row to be general throughout these plots. In this group two selections of Kanrad × Illini Chief known to have survived severe infestation the previous year were again outstanding in lack of injury.

Selections were made to further test some of the more desirable strains for resistance to chinch-bug injury and to provide material for a study of possible pathological and agronomic differences. During the crop season of 1936 sixty of these paired head selections of normal and stunted plants, with suitable checks, were grown in a special nursery at Manhattan. In addition to these, fourteen head selections of stunted and normal plants from like strains with checks were concurrently grown in three other wheat nurseries at Manhattan and in single nurseries at Parsons, Kan., Springfield, Mo., and Akron, Colo., and Lawton, Okla.[1] In all these plantings the number of chinch bugs present was insufficient to cause injury. Only slight differences in vigor of some of the plants occurred, and these were thought to be due to plumpness of seed. In general, plants from seed produced by stunted selections appeared to have normal vigor in both fall and spring growth. No significant differences related to stunting of plants or chinch-bug injury was observed in the selections tested.

SUMMARY AND CONCLUSIONS

Large numbers of chinch bugs overwintering and feeding on wheat under drought conditions at Manhattan, Kan., during the crop season of 1935 caused differential injury to appear among strains of wheat. Degree of injury to plants of various strains appeared to be related to feeding preference of the chinch bugs.

Observations on relative infestation and injury to 168 strains of winter wheat occurring in an area of heavy infestation show twenty percent of these strains to have suffered little or no injury from chinch-bug attack although plants of eighty percent of the strains were classed as moderately to severely injured.

Severe uniform stunting of plants occurred at harvest time in strains earlier observed to be injured. No stunted plants were found in uninjured rows.

In this test the plants most resistant as well as those most susceptible to drought and chinch-bug injury were soft wheats.

These tests have shown that some strains of winter wheat may be tolerant or, in a degree, resistant, to chinch-bug infestation. Since the prevention of chinch-bug population increase at its spring source in small grains seems to be an ideal way to control infestation, the reactions of different wheat varieties to chinch-bug infestation should be further investigated.

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1. For uniform test plantings at Manhattan we are indebted to Dr. John H. Parker, Dr. R. H. Painter, and C. O. Johnston. We are indebted to Dr. Hurley Fellows and R. O. Snelling for tests and observations at Akron, Colo., and Lawton, Okla.

The Life History and Control of the Boxelder Bug in Kansas[1]

By ROGER C. SMITH, and BYRON LEROY SHEPHERD,[2] Kansas State College, Manhattan, Kan.

The boxelder bug[3] is primarily a household pest and annoyance rather than a pest of the boxelder or any other trees. This pest flourished up to the beginning of the drought or about 1932 when it began to decline to almost

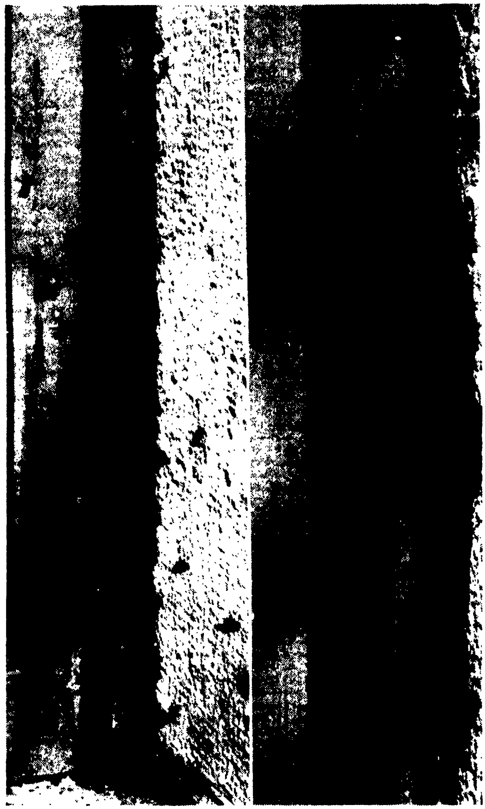

FIG. 1. Clumps of overwintering boxelder bugs on the south side of one of the college buildings on a warm day in February.

complete absence in the state in 1934, but in 1936 was definitely on the increase. It is therefore expected that there will soon be the usual number of inquiries about this insect and this account is written to make the results of investiga-

1. Contribution No. 445. Department of Entomology, Kansas State College.

2. This account is based on a thesis prepared by the junior author for the Master of Science degree at Kansas State College in June, 1933. This report embodies some observations made on Project No. 6 of the Agricultural Experiment Station.

3. The scientific name is *Leptocoris trivittatus* (Say) order Hemiptera, family Corizidae.

tions in Kansas and elsewhere available in anticipation of the normal boxelder bug population in the near future. It is a pest because of its habit of overwintering around homes. On warm days during the winter and spring, the overwintering bugs crawl out, enter homes and cause much annoyance to the occupants.

The accepted common name for this insect is "boxelder bug." The insect is often spoken of in Kansas as the "pop" bug, "populist" bug or the "democrat" bug. In the south it is often mistakenly called the "cotton stainer."

REVIEW OF LITERATURE

The boxelder bug has been the subject of considerable discussion in farm journals and papers of a semipopular nature. Much of this writing is in the form of short articles discussing the general habits and probable measures of control. There are no published reports of a detailed study of the boxelder bug in the literature.

The original description written by Thomas Say (1825) was made from specimens collected by him, while with Major Long's expedition to the Rocky Mountains in 1819-'20, at "Engineer Cantonment" which was near the present site of Omaha, Neb., on the west side of the Missouri river (Popenoe and Marlatt, 1888). Say originally placed the boxelder bug in the family Lygaeidae. Later it was placed by Stäl in the family Coreidae (Stäl, 1870), but present-day specialists in the Hemiptera place it in the family Corizidae.

The first real outbreak of the insect was reported October 22, 1891, from Columbia county, Washington, by I. N. Newkirk (Riley and Howard, 1892). Newkirk reported the insect as doing much damage to fruit such as apples, plums, grapes and peaches. Riley and Howard recommended the use of a dilute kerosene-soap emulsion for the control of the insect. Popenoe and Marlatt reported the insect as being numerous and to have been observed feeding on many plants such as ash, maple, ampelopsis, geranium, cacti, lilies, coleus and ageratum as well as on many other plants. The authors included a plate of illustrations showing the eggs, nymphs and adult forms.

This insect was reported from North Dakota in 1894 as having occurred in outbreak proportions (Lintner, 1894). The wingless nymphs were described as occurring in patches varying from four to five feet to 60 feet in diameter and "forming a deep, writhing mass."

In 1898 Gillette stated that he had tried kerosene emulsion, whale-oil soap, tobacco decoctions, zenoleum and pyrethrum, all very strong, and with no effect except to make the bugs uncomfortable for a time. He stated that whale-oil soap or kerosene emulsion may kill the nymphs.

Aldrich (1898) observed that the boxelder bug began mating about April 17 and that one week later eggs were found attached by the side to the boxelder trees and also attached to last-year strawberry leaves, at a distance of fifty yards from any boxelder trees.

The boxelder bug was quite widely distributed by 1898. Howard reported it as being known in Colorado, Arizona, California, Kansas, Missouri, Utah, and Mexico by 1880. In 1881 it was reported from Iowa. Up to 1887 there was no record of the insect east of the Mississippi river. In 1889 it was reported from Nebraska; 1891 from Washington state, Texas, Idaho, North and

South Dakota, Minnesota, Wisconsin and Illinois; and in 1894 from Pennsylvania (Howard, 1898).

Milliken (1911) discussed the history and methods of prevention of this annoying insect. He suggested the bug may have come from Mexico and that it probably was present here before 1820, but was not reported due to lack of competent observers.

Some of the more recent observations on the habits of the boxelder bug were made by Long in 1928. He observed that the insect showed a decided preference for the pistillate boxelder tree for feeding and for egg deposition. He reported that trees standing in the same yard with branches almost touching showed bugs only on the pistillate type of tree. He observed that the eggs were deposited on the fruit, usually in groups of three to eight, with only one group of eggs on each bunch of fruit. The eggs were glued flatwise to the side of the samara on the wing, in the curve just below the seed kernel and at the edge of the midrib of the fruit. Long suggested as a control of the boxelder bug the propagation of the boxelder tree from cuttings and thus grow only staminate trees.

Webster (1928) reported the boxelder bug as "sucking the juice out of all our apples" at Berrian, and that they were thickest on Red June and Delicious apples in Benton county, Washington.

The bug has been reported as damaging tulip bulbs (Swenk, 1929).

McDaniel (1933) reported that the boxelder bug has increased steadily for the last three seasons in several sections of Michigan. She recorded that some authorities contend only eggs deposited in opening buds of the pistillate boxelder trees hatched and produced young. She stated that when the bugs fed on fruit they caused it to become dimpled and deformed; that the young bugs fed through the summer and by early fall completed their growth. McDaniel stated that "the elimination of boxelder in the vicinity of houses would settle the local question of control measures for all time."

Deay (1928), in his taxonomic work on the Coreidae of Kansas, found that the claspers of the genital capsule of the male are constant in the species and are of decided taxonomic value (Plate 1).

Hutson (1932), of the Michigan State College, reported an infestation of boxelder bugs on everbearing strawberries, the eggs, nymphs, and adults being found on the plants. The nymphs and adults were feeding on the foliage and fruit, with the result that the entire crop was lost and the plants apparently much damaged. Many plants were killed outright.

Ruggles (1935) stated that the boxelder bug was a native American insect whose original home was probably in the southwest. It had not been reported north of Missouri in 1888, but since it has spread into most states northwest of the Mississippi and many eastern states. He also pointed out the close correlation between abundance of this insect and dry weather. In Minnesota it is regarded as a dry weather plague with two generations a year.

McDaniel (1936) obtained excellent control both of adults and nymphs by using a sulfonated higher alcohol spray against them. A common representative of this material is "dreft," which is sold as a cleaning compound used at the rate of 1 teaspoonful to 1 quart of water. It did not injure paint on buildings nor vegetation. She reported by letter approximately ninety percent control by use of pyrocide.

DESCRIPTION OF LIFE STAGES

The Egg

The egg of the boxelder bug is light straw-color when first oviposited. It turns darker brown color within a few hours and gradually becomes darker red until it is dark reddish-brown color before it hatches. The egg is oval

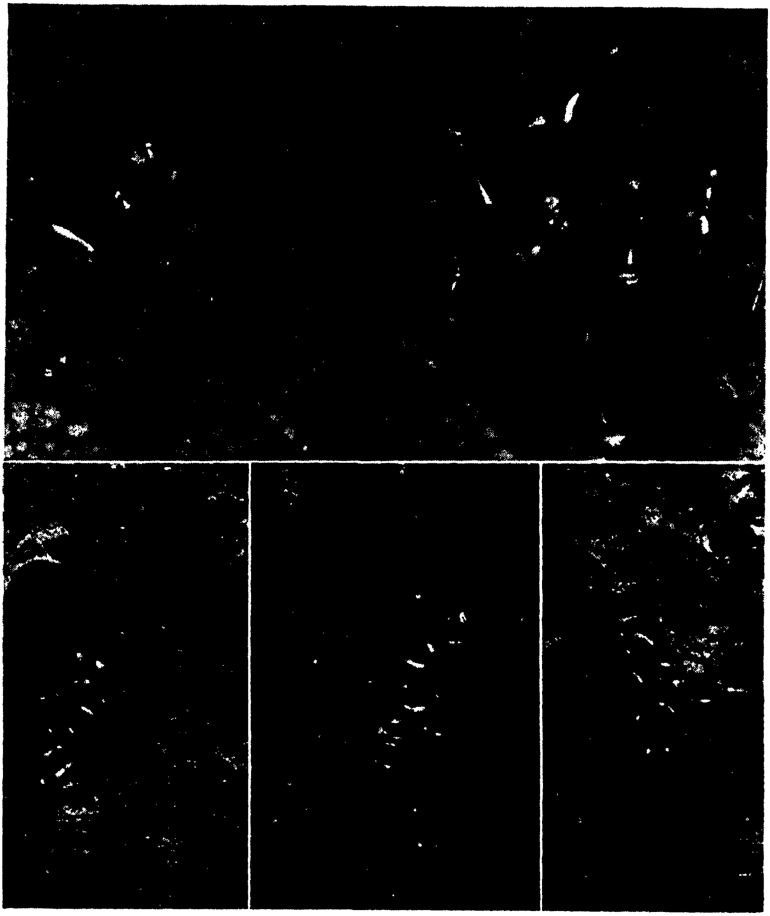

Fig. 2. (Upper half.) Hatched and unhatched eggs of the boxelder bug deposited in rearing cages on the underside of strawberry leaves. The eggs at the left in which a rent occurs from which the whitish embryonic molt protrudes have hatched.

(Lower half.) Boxelder bug egg masses on the underside of pieces of loose bark from large maple trees on the college campus.

in outline and measures 1.30-(1.48)-1.66 mm. in length and 0.77-(0.86)-1.00 mm. in diameter. The egg has a distinctly marked cap at one end which is nearly as large as the end of the egg. In this cap occurs a circular structure, the micropyle (Fig. 2).

Nymphal Stages

The nymph upon emergence from the egg is bright red. The antenna, legs, head and thorax soon turn darker reddish. The nymph is sparsely covered with short, bristly hairs. The length of the nymph at hatching is approximately 1.6 mm. The abdomen becomes larger with nymphal feeding. For indications of instars and moulting, the nymphs were measured between the external margins of the compound eyes. This measurement is comparatively uniform in each instar.

The nymphs of the second and third instars are similar in appearance to those of the first instar. The antenna, head, legs and thorax are slightly darker red than in the first instar.

The nymphs in the fourth instar have small slate-colored wing pads which may be seen through the outer covering of the thorax. The posterior tip of the wing pads are not free in this instar (Plate I, Fig. 6).

The wing pads are darker slate color and are free at the posterior tips in the fifth instar. The small pads cover approximately one fourth of the abdomen. The legs and antenna during this instar become almost black.

The elongate, slate-black wing pads project backward from the thorax over each side of the front one third of the abdomen, in the sixth instar. The body of the nymph in this instar becomes darker red with light slate colored markings on the dorsum.

Adults

The adult boxelder bug has an elliptical body, with a pointed head which bears a projecting eye on each side. The color at moulting is bright red, which gradually changes to slate black on the dorsal side, except the compound eyes and ocelli, which remain red. The three stripes which give to the insect its specific name (one on the middle line of the thorax and one on each margin of the body from the head to the outer corner of the thickened base of the wings) and a V formed by the stripes that converge forward where the thick and thin parts of the wings unite, remain a reddish color. The red color is retained, on the ventral surface, on the coxae, the posterior margin of the metathorax, the median line of the abdomen to the last segment, and the outer margins of the abdomen to the last segment. The part of the body covered by the wings also remains red. The legs are slender and the four-segmented antennae are elbowed, with the distal segment of each slightly enlarged (Plate I, Fig. 8).

Sex Differences

The sexes of the boxelder bug may be distinguished by the genitalia and the size of the body. The genital capsule of the male, from the ventral aspect, reveals a pair of claspers. There is also a projection, from the ninth abdominal segment, on each side of the claspers (Plate I, Fig. 9). This gives the abdomen of the male the appearance of having four distinct projections at the posterior end. These projections on the abdomen make the male easily distinguished from the female, which has no special structures of the genitalia visible from the ventral aspect, other than a tubular segmentation. The female boxelder bug is slightly larger than the male. The variation in size is shown in Table I.

TABLE I.—Variation in size of 100 adult male and female boxelder bugs

	Body length in mm.		Width of thorax.		Width across eyes.	
	Male.	Female.	Male.	Female.	Male.	Female.
Maximum	12	14.5	4.5	5.0	3.3	2.38
Average	11.43	13.18	4.06	4.66	2.1	2.18
Minimum	10	12	3.5	4.0	2.0	2.0

Sex Ratio

Table II shows that there is a predominance of females in this species of insect.

TABLE II.—Proportion of sexes in collections

Number collected.	Date of collection.	Place of collection.	Number of males.	Percent of males.	Number of females.	Percent of females.
550	November, 1932	East Agricultural hall	198	36	352	64
450	March, 1933	College buildings	175	39	275	61
160	Various	College collection	39	37	67	63

OVERWINTERING HABITS

The boxelder bug overwinters in the adult stage. The more noticeable hibernating places at Manhattan, Kan., were found to be around the foundations and windows of buildings. The bugs commonly hibernate under leaves and other debris which has gathered under hedges, in road ditches and in other similar places. They also hibernate in old buildings, in stone, lumber and wood piles, in clay banks, quarries, under the bark and in hollows of trees.

The bugs began to seek places of shelter about October 1, 1932. By the middle of October, great numbers of the bugs were seen clustering on the south and west sides of the stone buildings on the campus. Many bugs were seen clustering and swarming along clay banks, on Wildcat and Cedar creeks near Manhattan, and going into hibernation in much the same places as do certain wasps (*Polistes* sp.). On warm days throughout the winter the bugs appeared in clusters outside their places of hibernation around buildings. A seldom used room, in a residence in Waldo, Kan., was heated on November 28, 1932, and many boxelder bugs appeared. Some of the bugs were crushed on the rug and upholstered furniture. The habit of crawling into the house throughout the fall, winter and spring makes the bug a very annoying pest.

At Manhattan, in 1933, the insects began to leave their places of hibernation about the last week in March and by the middle of April practically all had left their hibernation quarters. The bugs fed approximately two weeks before copulation and oviposition took place.

During the winter of 1935-1936, the bugs hibernated in considerable numbers among the layers of limestone in a railroad cut southeast of Manhattan. The

bugs became active in early March and began spreading from their winter quarters. The numbers around the south sides of buildings during the spring were remarkably few.

DISTRIBUTION

The boxelder bug has been reported in the United States from twenty-seven states; namely, Washington, Oregon, Califorina, Idaho, Utah, Arizona, New Mexico, Colorado, Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Michigan, Ohio, Indiana, Kentucky, North Carolina, Maryland and Pennsylvania. It has been reported from Mexico and three provinces of Canada; namely, Quebec, British Columbia and Saskatchewan.

The insect has not been reported from the states of Wyoming, Nevada, Arkansas and Louisiana west of the Mississippi river, but considering its reported distribution it is logical to assume that it is present in at least Wyoming and Nevada. The insect has not been reported south of North Carolina in the southeastern one fourth of the United States. It has not been reported from the New England states. Since the boxelder bug, however, is found in Ottawa, Canada, Pennsylvania, Maryland and North Carolina, it probably is also present in New York, West Virginia and Virginia.

LIFE HISTORY STUDIES

The life history studies of the boxelder bug were begun during the last week of September, 1932. General observations were made as to the feeding habits, place and time of hibernation. Boxelder cuttings were planted, on October 10, in pots of moist sand, to provide host plants for rearings. These cuttings took root slowly and did not leaf out until about December 20. Strawberry plants were set in pots and these with the boxelder cuttings served as host plants for bugs during the late winter and early spring. The rearings were carried on in the greenhouse until April 15, when similar experiments were carried on out of doors.

Bugs were collected on warm days during the winter and placed in screen cages, which were placed over growing boxelder and strawberry plants in the greenhouse. The warm temperatures of the greenhouse had little effect upon the bugs and no eggs were laid until March 23, which was only four weeks earlier than those found in natural conditions. A few eggs were laid early, but no nymphs were reared to the adult stage from these eggs.

The most successful rearings were conducted on leaves and stems confined in small fruit jars and jelly glasses. Newly hatched and freshly molted nymphs were placed in the jars, fed and observed daily. The leaves and stems of boxelder, pin oak, soft maple, pigweed and crabgrass were used for food.

Dyar's law was applied in checking the number of instars through which the boxelder bug passed. The rate of increase between two successive molts was determined and then by the application of the law the number of molts was computed. The rate of increase between the fifth and sixth molts was found to be 0.83. A comparison of the observed widths of the head capsule and the calculated width is given in Table III.

TABLE III.—Observed and calculated head widths of boxelder bug

INSTAR.	Number of insects.	Observed minimum measurement in mm.	Observed maximum measurement in mm.	Observed average measurement in mm.	Calculated measurement constant 0.83.
First	55	0.56	0.66	0.64	0.68 (0.82xc)
Second	58	0.7	0.83	0.78	0.82 (0.99xc)
Third	41	0.86	1.0	0.9	0.99 (1.2xc)
Fourth	62	1.1	1.26	1.17	1.24 (1.5xc)
Fifth?	91	1.43	1.6	1.51	1.51 (1.82xc)
Sixth	71	1.7	1.93	1.83	1.82 (2.2xc)
Seventh	100	2.0	2.33	2.18	....

A comparison of the figures of the observed series with those of the calculated series indicates that no instars were omitted.

LENGTH OF LIFE STAGES

Egg Period. The period of incubation of the boxelder bug was found to vary from eleven days to 19 days, the average length being 13.75 days. The length and variation in the period of incubation is given in Table IV.

TABLE IV.—Incubation period of the boxelder bug

Date of oviposition.	Date of hatching.	Length of incubation period in days.	Place of incubation.	Number of eggs.
1933. March 25	April 8	14	Greenhouse	19
March 27	April 9-10	13 and 14	Greenhouse	38
March 30	April 13	14	Greenhouse	9
March 30	April 13	14	Adv. laboratory	21
April 28	May 12	14	Adv. laboratory	10
April 28	May 9-10	11 and 12	Greenhouse	27
April 28	May 17	19	East insectary	*
April 30	May 14	14	Adv. laboratory	12
May 14	May 26	12	Adv. laboratory	32
May 14	May 28	14	East insectary	10

* Large number, not counted.

The peak of oviposition for the spring generation of the boxelder bug, in the vicinity of Manhattan, was from April 20 to May 10, 1933. The greatest mating activity was observed April 27. The females laid their eggs in the immediate vicinity of the mating grounds. The eggs were observed on stones, leaves, grasses, trees and shrubbery. The majority of the eggs laid early in the season were deposited in the crevices of the bark of trees, especially on the

underside of the pieces of bark. The old maple trees, which had rough bark, were especially favorite places for oviposition. Many eggs were found on the underside of twigs and limbs of pin oak. The bugs began depositing a considerable number of eggs on the leaves of pin oak about May 10, and a few were deposited on the leaves of soft maple and strawberry.

The boxelder bugs came out of hibernation and fed approximately two weeks before mating and laying their eggs. The females laid an average of about ten eggs each, which were placed singly or in more or less irregular clusters (Fig. 3). The clusters usually numbered from three to ten eggs. No female, kept alone in a rearing cage, laid over twelve eggs. The period of oviposition in most cases was confined to one day, the eggs, usually, all being laid within a few hours. One female was observed to lay five eggs within a period of forty minutes. Females kept in the rearing cages were all dead within a period of eleven days after having laid their eggs.

The eggs were flattened flatwise to the side of cages with a glue-like substance as they were laid. The proximal end of the egg, characterized by the cap and micropyle, is raised slightly from the substratum.

Nymphal Period. The nymphal period varies from fifty to seventy-eight days, with an average length of 59.5 days. The time in days between molts is given in Table V.

TABLE V.—Number of days between molts in the boxelder bug

	1st molt.	2d molt.	3d molt.	4th molt.	5th molt.	6th molt.	Total days hatching to adult.
Maximum	8	9	14	11	17	19	78
Minimum	3	5	7	10	12	13	50
Average	4.3	6.1	9.3	10.5	14.3	15	59.5
Number insects averaged	32	19	9	6	6	10	....

Number of Generations. Observations indicate that the number of generations of the boxelder bug in Kansas is two. Nymphs ranging from the third instar to newly molted adults have been repeatedly seen as late as October. The nymphs hatched in 1933 were practically all in the adult stage by July 20.

McDaniel (1933), of Michigan, reports the nymph feeds throughout the summer, reaching maturity in early fall, thus inferring that there is but one generation. Long (1928), of New Mexico, in reporting his observations, infers that there are two generations of the insects.

NATURAL CHECKS

Climatic

The effect of low temperature on the boxelder bug was tested by placing 185 adult insects in a cigar box and placing the box on the window sill of the laboratory. Fifty-seven insects or thirty-one percent were killed by a temperature of 10° F. The others were all dead after two consecutive nights with the temperature reaching —10° F.

A box containing approximately 150 bugs was placed in an electric refrigerator, in the dairy department, October 18, 1932, and maintained at an approximate temperature of 40° F. for one week, and then at an approximate temperature of from 12° to 24° F. for another week and then left at approximately 40° F. for four weeks. The insects were all dead when removed from the refrigerator.

Considerable numbers of the boxelder bugs were found dead, during February and March, in places of hibernation such as the underside of loose bark of the soft maple trees and just below the soil in the crack between the earth and the foundation of the east Agricultural hall, Kansas State College.

It is apparent that the boxelder bug cannot withstand continued extreme cold for any length of time without considerable protection. During the winter of 1932-'33 a temperature of —18° F. was reached at Manhattan. This temperature apparently caused considerable winter-killing among these insects. Newcomer (1928) stated that a mild winter (minimum temperature of 12° F.) killed practically no boxelder bugs in the Yakima Valley.

High summer temperatures appear to affect the behavior of the boxelder bug. During the part of the day when the temperature was high, great numbers of the insects were found clustered under the edges of bark and around the base of trees. This was especially true of the older nymphs and adults. Many others and especially the younger nymphs were found under leaves and in the grass and weeds. The bugs remain near the ground during the heat of the day.

The high summer temperatures of 1934 and 1935 apparently destroyed the nymphs. A fair population of newly hatched nymphs was seen in the spring of 1934, but the species grew scarcer as the summer proceeded. The smallest number of bugs observed in years went into hibernation in the autumn. The species was able to increase somewhat in 1935 though the hot, dry summer was again unfavorable. While this species prefers dry weather, it appeared that the upper limit of tolerance was passed during these two years.

The boxelder bug is easily drowned. When they become wet, they are almost helpless. This is especially true of the smaller nymphs. Many nymphs and adults were found dead on the ground after a hard rain on June 25 and July 8, 1933. There was a high rate of mortality with the nymphs kept in moist rearing jars. If a few drops of moisture formed in the jar, they usually drowned.

Natural Enemies

Parasites. The boxelder bug is exceptionally free from insect parasites. Four hundred fifty-two eggs were collected from trees and hatched under observation, with no emergence of insect parasites. No black eggs, which is generally the color of those parasitized, were found.

McCulloch (1916) found the adult boxelder bug to have immense numbers of parasitic flagellates in the intestinal tract. Mature bugs showed 100 percent infestation. McCullough states that apparently the parasitic flagellates do no harm to the insect. Many of the bugs with which Miss McCulloch worked came from Manhattan.

Predators. Observations were made of robins, blackbirds, thrashers and sparrows feeding where the boxelder bugs were numerous and in no instance was a bird seen to catch or eat any of the bugs. The boxelder bug when

crushed gives off a pungent odor. This odor is produced by glands common to hemipterous insects. No predators except spiders were observed to feed on the boxelder bug.

Fungus. Many dead boxelder bugs, which were collected out of doors and taken from the rearing cages, were examined for fungus. No evidence of death having been caused by fungi was observed.

HOST PLANTS AND FOOD HABITS

Contrary to general belief the boxelder bug feeds on a wide variety of plants. It was observed feeding on twenty-three known plants; namely, soft maple, ash, pin oak, boxelder, tree of heaven, mulberry, honey locust, buckeye, linden, spirea, ampelopsis, cactus, lilac, honeysuckle, iris, hollyhock, geranium, tulip, peony, asparagus, pigweed, crabgrass, foxtail grass, as well as on several unidentified weeds, shrubs and grasses. The insect was observed feeding especially on grasses, weeds and fruit of soft maple. It has also been recorded many times as feeding on such fruits as the apple, plum, grape and peach.

The boxelder bug is slightly cannibalistic. It also feeds on injured or dead bugs. The bugs were observed feeding on a dead cicada and on a ground beetle. They pierce the tissue of a plant or fruit and suck the liquid from it. They cause much injury and even kill such plants as the strawberry (Hutson, 1932). Their feeding on ripening fruit causes it to become unsalable. Excessive numbers of the insect feeding on the berries left them dry and fibrous.

Approximately sixty adult bugs were placed on a single fruit-bearing strawberry plant. In five days the plant began to show noticeable signs of weakening, the three berries on the plant were entirely ruined by the work of the bugs in four days. This plant was keep well watered. A similar plant was infested with approximately fifty adult bugs. This plant was not watered excessively and at the end of a ten-day period the plant was almost dead.

MEASURES OF CONTROL

Many insecticides have been reported as being used to control the boxelder bug. Twelve insecticides were tested, in this work. A list of the insecticides with the results obtained under greenhouse conditions is given in Table VI.

A list of the insecticides with the results obtained under conditions comparable to natural conditions is given in Table VII.

Kerosene applied undiluted proved to be the most effective inexpensive commercial product used for controlling the boxelder bug. The spraying of the adults so that they were damp with the oil gave a good kill. It was not necessary to apply the kerosene so heavily to obtain good results against the nymphs. Kerosene should not be applied to growing plants or flowers. Its application on the bases of trees seemed to have no ill effects.

The application of hot water (165° to 180° F.) was undoubtedly the most effective method of killing the bugs. Hot water poured with a long handled dipper directly on the insects gave excellent control. Water at a temperature of 180° F. had no apparent damaging effects upon the tree when applied to the bugs as they were clustered about the base. The hot-water treatment should be used on the bugs that cluster about the bases of trees and around windows and foundations.

The application of cold water in large quantities by dashing it on the bugs gave fairly good control. From the results obtained by this mode of applica-

TABLE VI.—Insecticides, with results obtained under greenhouse conditions

INSECTICIDE.	Strength.	Stage of insect.	Number of insects.	Number dead in 8 hours.	Number dead in 24 hours.	Temperature.	Humidity.	Percent dead.
Black-leaf 40	1-800	Adult	20	0	1	91	30	5
Black-leaf 40	1-400	Adult	10	1	1	91	30	5
Black-leaf 40	1-200	Adult	15	1	2	75	51	13
Black-leaf 40	1-100	Adult	15	3	3	75	51	20
Black-leaf 40	1-25	Adult	20	5	7	77	44	35
Kerosene	Pure	Adult	65	45	55	82	44	84
Kerosene	Pure	Adult	22	16	20	73	45	90
Kerosene	Pure	Adult	27	20	20	71	56	74
Kerosene	Pure	Small nymph	5	5 dead in 1 hour.	...	...	...	100
Kerosene	Pure	Small nymph	7	5 dead in 1 hour.	7 dead in 1 hour.	...	...	100
Kerosene and Black-leaf 40	1-50	Adult	74	56	60	79	54	81
Superla	...	Adult	52	10	12	68	58	12
Flit	...	Adult	22	13	14	70	60	63
Raleigh insect powder	...	Adult	26	9	11	70	60	40
Fish oil soap	¼ to 2½ gals.	Adult	32	4	5	78	52	15
Fish oil soap	½ to 2 gals.	Nymph	28	12	14	73	56	50
Fish oil soap nicotrol	½ to 2 gals. and 1-100.	Adults	30	18	18	80	45	60
Laundry soap	½ to 2 gals.	Nymph	20	4	7	72	54	35
Pyrethrum powder	...	Adult	14	2	2	87	34	14
Cyanogas	...	...	12	10 dead in 1 hour.	...	74	40	83
Nicotrol	1-100	Adult	25	7	...	76	75	28
Nicotrol	1-50	Adult	21	8	...	76	55	38

TABLE VII.—Insecticides with results obtained under natural conditions

INSECTICIDE.	Strength.	Stage of insect.	Number of insects.	Number dead in 12 hours.	Temperature.	Humidity.	Percent dead.
Kerosene	Pure	Large nymph and adult	28	17	58	68	60
Kerosene	Pure	Small nymph	15	13	78	78	86
Nicotrol	1-100	Large nymph	12	3	100	52	33
Nicotrol	1-50	Large numph	19	12	94	66	42
Nicotrol	1-25	Nymph and adult	21	12	92	65	57
Black-leaf 40	1-100	Large nymph	18	3	92	88	17
Black-leaf 40	1-50	Large nymph	18	5	82	85	28
Flit	....	Large nymph	10	2	101	81	20
Raleigh insect Spray	....	Large nymph	10	3	86	66	30
Fish oil soap	½ to 2 gals	Large nymph	23	8	86	66	35
Fish oil soap and Nicotrol	½ to 2 gals. and 1-100,	Large nymph	25	16	95	67	64
Water	140° F	Large nymph	10	At end of 20 min. 2 dead	....	....	20
Water	165° F	Large nymph	10	At end of 20 min. 2 dead.	....	....	80
Water	180° F	Large nymph	17	At end of 20 min. 17 dead.	....	....	100

tion, it appears to the writers that the application of quantities of water which is under pressure with an ordinary hose would drown a great many of the insects and aid measurably in their control.

Insecticides in general, other than kerosene, gave unsatisfactory results. Of those tested, fish-oil soap, one half pound to two gallons of water, with nicotrol at the rate of one gallon of nicotrol to 100 gallons of water, plus soap at the rate of one half pound to two gallons of spray, gave a maximum kill of sixty-four percent. This is only partial control, but the sprays can be used on plants which are attacked by boxelder bugs such as iris and strawberries. Nicotine sulfate (Black Leaf 40) at commonly recommended dilutions with soap added gave unsatisfactory results against all stages of the boxelder bug. Likewise a three precent solution of a dormant spray oil, Derrisol at recommended dilutions and nicotine sulfate plus a summer oil were all ineffective against adults in laboratory tests.

Therefore, the only control measures recommended are (1) Spraying the bugs when not on vegetation with kerosene; (2) pouring hot water on them and (3) applying cold water by means of a hose to nymphs on the ground or for washing them forcefully from vegetation so that they may be drowned.

PREVENTION

Much of the damage and annoyance from the boxelder bug can be eliminated by the exercise of a few preventive measures. The boxelder bug nymphs were found to be local in their distribution. Most of the bugs which were hatched on the campus remained near the place of hatching until their place of shelter was removed, after which the bugs moved about 100 yards to new shelter. The shelter consisted of an accumulation of leaves, along a stone wall. Inasmuch as the nymphs live in such places as accumulations of old leaves, grass and other debris, it follows that the removal of such protective covering will remove the pest from the immediate vicinity.

The elimination of the boxelder trees near houses as recommended by McDaniel of Michigan, and the use of only staminate boxelder trees as recommended by Long of New Mexico would be of little or no value as a control measure for the boxelder bug in Kansas. In the investigations made during these studies no eggs of the boxelder bug were found on the boxelder tree, nor any clusters of the bugs on the pistillate boxelder trees on the campus or near Manhattan. The best mode of prevention would appear to be the removal of protective shelter for the nymphs from the region or building to be protected.

SUMMARY AND CONCLUSIONS

The boxelder bug is known chiefly as a household pest in Kansas. The insect requires from fifty to seventy-eight days for its growth from egg to adult. The egg undergoes an incubation period of approximately two weeks. The nymphs molt six times and the total average time for the molts is two months.

The nymphs spend a greater part of their lives in weeds, grasses and under accumulations of old leaves. The insect was observed feeding on twenty-three known plants as well as on several unidentified ones, but chiefly on weeds and grasses.

The two best methods of control appear to be through prevention by removal of cover, and the application of hot water or kerosene on masses of adult bugs and drenching nymphs with cold water using a hose.

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PLATE I

FIG. 1. Ventral view of the end of the abdomen of the male boxelder bug, showing genital claspers.

FIG. 2. Similar view of the female boxelder bug.

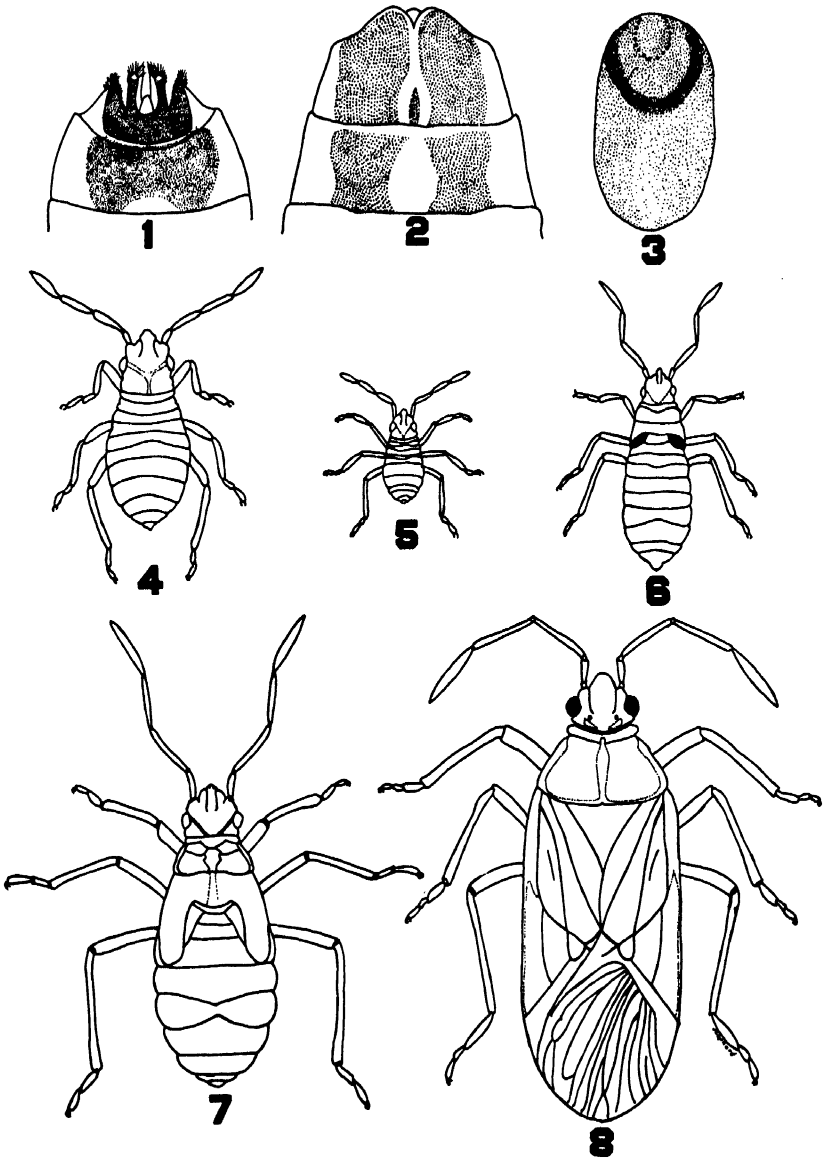
FIG. 3. Boxelder bug egg showing the prominent cap at one end within which is the micropyle (shown by dots).

FIGS. 4 to 6. Nymphal instars: Fig. 5 is newly hatched nymph; fig. 4 is the third instar; fig. 6 is the fourth; fig. 7 is the fifth instar.

FIG. 8. Adult.

(All drawings by the junior author).

PLATE I



The Biology and Synonomy of the Parasites of the Strawberry Leaf Roller, *Ancylis comptana* Froel. (Lepidoptera, Tortricidae), Found in Kansas[1]

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INTRODUCTION

While making a biological study of the strawberry leaf roller (*Ancylis comptana* Froel.) in 1929, it was found that the outbreaks of this insect had been quite local, that they appeared rather suddenly and were quite destructive and that infestations disappeared almost as suddenly as they appeared. Outbreaks seldom occurred twice in the same locality except where a considerable number of years had elapsed between the outbreaks. This suggested the possibility of parasites playing a rather large part in the fluctuations in numbers of this insect. In the spring of 1929, in the vicinities of Manhattan and Wamego, these leaf rollers were so plentiful that it appeared that great injury might be done to the strawberry fields. By the last of May the infestations were growing lighter and were materially reduced by June 8. By this time parasitized larvae and pupae could be found in the rolled leaves. Since evidence showed that parasites were playing an important part in the activities of this insect, a study was made to determine the species which were responsible for the beneficial results in the control of this leaf roller and if one species was more responsible for the reduction of leaf roller infestation than another. Eighteen hymenopterous and two dipterous parasites are discussed in this paper.

ECONOMIC IMPORTANCE

Webster (*109*), in his study of the strawberry leaf roller, rarely found a braconid cocoon. Lewis (*73*) reported that in accounts of outbreaks, parasites have not been mentioned as common. Little other mention is made of parasites in the literature. In Kansas the situation appears to have been somewhat different. The fact that infestations have been local, and seldom, if ever, occur twice in the same place without the lapse of several years and the fact that severe infestations disappear where no effort is made to stop them, indicates that under Kansas conditions parasites play a rather important part in keeping this leaf roller under control.

METHODS OF REARING PARASITES

Larvae of the strawberry leaf roller were collected for biological study from the strawberry fields and confined in cages with a small amount of strawberry leaf for food and a small amount of blotting paper to hold water to regulate the moisture. Life history studies ceased in the laboratory early in June, due to the fact that all or nearly all of the larval hosts were parasitized. Two types of cages were used and both types were very satisfactory. One type of cage

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1. This paper is a partial fulfillment of work for a master of science degree and was done under the direction of Dr. R. L. Parker of the Kansas State College of Agriculture and Applied Science, to whom the writer wishes to express thanks for the general supervision of the work and for bibliographical work in the preparation of this paper, as well as suggestions and criticism of the paper. Credit is due Dr. Harold Morrison and his co-workers of the United States National Museum, Washington, D. C., for the determination of the species of parasitic Hymenoptera and for supplying certain information about them which could not be obtained from libraries. Credit is also due Mr. H. J. Reinhard of the Texas Agricultural Experiment Station for the determination of the two species of dipterous parasites.

2. Junior entomologist, Bureau of Entomology and Plant Quarantine.

was a small shell vial plugged with cotton. This type of cage permitted examination for detection of the emergence of parasites without opening the cage. The other type of cage was a one-ounce tin salve box. The strawberry leaf did not dry out so readily in this cage, but it was a little more difficult to examine the larvae without allowing any parasites, which had emerged, to escape. This was overcome by using a corrugated cardboard box (about 12" x 8" x 6") with a pane of glass (8" x 6") fastened in the top. Two holes were made in one end or on either side of the box to permit manipulation. A cloth flap covered the holes. This device can be improved by fastening extra pieces of cardboard or paper diagonally across the upper corners of the box on the inside, so that the sides would curve gradually to the glass instead of leaving corners in which the liberated parasite could hide. The inside of the box should be painted white to reflect light and form a background on which the black or brown insects would be easily seen. The tin boxes were examined in this trap to recapture escaping parasites. These cages were examined daily; moisture and fresh leaves, which had been carefully examined to see that no other insect was introduced, were added as needed. Only one larva was kept in each cage.

SYNONOMY

Discussion, Distribution and Hosts of Parasites

Apanteles canarsiae Ashmead (7). 1897. (Braconidae)

Muscbeck (76) in 1921 gave the synonomy of this insect as follows:

Urogaster canarsiae Ashmead. Proc. Ent. Soc. Washington, 4, 127. 1897.
Apanteles (Apanteles) hausatannuckorum Viereck. Conn. Geol. and Nat. Hist. Survey, Bul. 22, 189 and 198. 1916.
Apanteles (Apanteles) maquinnai Viereck. Conn. Geol. and Nat. Hist, Survey, Bul. 22, 190 and 199. 1916.

Chittenden (*19*), Frost (*38*) and Hough (*51*) list *A. canarsiae* as a parasite of the red-banded leaf roller, though the latter did not rear it from this host. Johnson and Hammer (*65*) list it as a parasite of the grape-berry moth. Slingerland (*88*) states that it is parasitic on the apple leaf skeletonizer. Strauss (*90*) listed it as a parasite of the grape leaf folder.

Six specimens of this species were reared from strawberry leaf-roller larvae which were collected from Wamego.

Distribution: Illinois, Virginia, Iowa, Connecticut and the District of Columbia (all *76*).

Hosts:

Desmia funeralis Hubner	Grape-leaf folder.
Polychrosis viteana Clem.	Grape-berry moth.
Eulia velutinana Walk	Red-banded leaf roller.
Psorosian hammondi Riley	————
Canarsia hammondi Riley	Apple leaf skeletonizer.

Brachymeria ovata (Say). 1824. (Chalcididae)

Dalla Torre (*29b*)[3] lists the synonomy of this insect as follows:

Chalcis flavipes Fab. Entom. System., II, 197. 1793.
Chalcis flavipes Fab. Syst. Piez., 167. 1804.
Chalcis flavipes Jurine. Nouv. Meth Chass. Hymen., 315. 1807.
Chalcis ovata Say. Keatings Narrat Exped., II, 326. 1824.
Chalcis annulipes (Laporte) Walker. Entom. Magaz., II, 29. 1834.
Chalcis ovata Leconte. Writ. of the Say Ento., I, 219. 1859.
Chalcis inerta Cresson. Proc. Entom. Soc. Phila., IV, 101. 1865.

Brachymeria panamensis Holmgren. Eugenies Reca. Insect., 437. 1868.
Chalcis ovata Cresson. Trans. Amer. Ent. Soc., IV, 59. 1872.
Chalcis ovata Lintner. 1st. Ann. Rep. Insects, New York, 86. 1882.
Chalcis flavipes W. F. Kirby. Jour. Linn. Soc. Zoöl., 17, 68. 1883.
Chalcis ovata Cameron. Biol. Cent. Amer., 31. Hymen., I, 99. 1884.
Chalcis ovata Provancher. Addit. Faun. Can. Hymen., 190. 1887.
Chalcis flavipes Howard. Scudder, Butterflies U. S. 88, 1889: Figs. 14-15.

There is considerable comment in the literature regarding the economic value of *B. ovata* (Say). Howard (*53*) listed *Chalcis flavipes* Fab. as a secondary parasite of *Tachina larvarum* L. which was being imported at that time as a primary parasite of the gypsy and brown-tail moths. In another paper (*54*) he speaks of importing *Chalcis flavipes* and liberating them, and in still another paper (*58*) he says, "*Chalcis ovata* Say has never been reared as a parasite of the gypsy moth, although it is not improbable that it will be found to attack it when the moth shall extend its range southward into territory where the chalcid is more common than it appears to be in eastern Massachusetts."

According to Britton (*11*) Howard, in 1895, reported that ninety percent of the white marked tussock moths were killed by parasites, and *B. ovata* was rated second in the list. Tucker (*97*), reporting on the elegant looper, states that a large proportion of the pupae are killed by parasites and that *Chalcis ovata* proved to be the prevalent parasite. Watson (*107*) states that *C. ovata* prevents the okra caterpillar from becoming a greater pest. Horton (*52*) states that *C. ovata* frequently attacks a butterfly which is injurious to orange trees in California. Fracker (*36*) gives *C. ovata* and two other parasites the credit for reducing to a minimum a species of tussock moth which was doing serious damage in 1922. Walcott (*116* and *117*) reports that the cotton worm is largely kept in check in Puerto Rico by parasites which include *Chalcis inerta* Cress.

This species did not appear to be of great importance as a parasite of the strawberry leaf roller in 1929.

Distribution: New Mexico (*1*); Tenn. (*2*); Conn. (*11*); La. & Texas (*30*); La. (*97*); Wis. (*36*); Calif.(*52*); Texas (*59*); N. Y. (*72*); Va. (*84*); N. C. (*89*); Neb. (*92*); Fla. (*107*).

Hosts:

Hemileuca sp.	Hemileuca moth
Pyrausta penitalis Grote	Lotus borer
Anticarsia gemmatilis Hubner	Velvet bean caterpillar
Cosmophila erosa Hubner	Okra or mallow caterpillar
Olene leucophaea A. & S.	Tussock moth sp.
Hemerocampa leucostigma S. & A.	White marked tussock moth
Papilio zolicaon Boisd	A swallow-tail butterfly
Thyridopteryx ephemeraeformis Haw	Bagworm sp.
Alabama agrillacea Hubner	Cotton worm
Tachina larvarum L.	Tachinid fly
Hemileuca oliviae Ckll	New Mexico range caterpillar
Diaphania nitidalis Stoll	Pickle worm
Philtraea elegantaria Hy. Edw	Elegant looper
Eurymus eurythema Boisd	Alfalfa caterpillar

3. Attention is called to the fact that there is some doubt about the synonomy of these names (see synonomy listed above). Dr. Harold Morrison, of the United States National Museum, states (in personal letter) "Dalla Torre's catalogue is not to be followed in the synonomy of the species." There seems to be no publication at this time that is reliable for the synonomy of this species. Where there is no later publication giving the synonomy, Dalla Torre's catalogue is referred to.

Casinaria infesta (Cresson) (*23*). 1872. (Ichneumonidae)

Gahan (*40*) gives the following synonyms:

Limneria infesta Cresson. Amer. Ent. Soc., 4, 172. 1872.
Limnerium sessilis Ashmead. Proc. U. S. Nat. Mus., 12, 483. 1890.
Limnerium erythrogaster Ashmead. Proc. U. S. Nat. Mus., 13, 434. 1890.
Limnerium ashmeadi Dalla Torre. Cat. Hymen., 3, 90. 1901.
Anemphere̵s diaphaniae Viereck. Proc. U. S. Nat. Mus., 4, 188. 1912.
Amorphota orgyiae Howard.
Chittenden (20) used *Amorphota infesta* Cresson.

Hamlin (*48*) listed *C. infesta* as the foremost parasite of *Mimorista flavidissimalis*. There seems to be some doubt as to the species. Swezey (*95*) says this parasite cannot be considered of much importance in Hawaii, since the hosts which it attacks are largely kept under control by other native parasites. He says, however, that when a larva of any one of nine different pyralids is found to be parasitized, it is more often parasitized by *C. infesta* than any other species. Viereck (*100*) says this species was bred from a pupa of *Diaphania hyalinata.*

In this work only one specimen was reared from the strawberry leaf roller, *Ancylis comptana,* and therefore did not appear to be of very great importance for this host under Kansas conditions.

Distribution: D. C. (*6*); Alabama (*6*); N. C. (*100*); Cal. (*20*); Texas (*48*); and Hawaii (*95*); Florida to Maryland and west to Kansas and Texas (*95*).

Hosts:

Phlyctaenia rubigalis Green	The celery leaf-tyer
Mimorista flavidissimalis Grot	————
Diaphania hyalinata L.	Melon worm
Hymenia fascialis Cr.	Hawaiian beet webworm

Chorinaeus n. sp. (Ichneumonidae)

Seventeen specimens of this species were reared from the strawberry leaf roller larvae collected at Leavenworth. The species was determined as new at the United States National Museum and fifteen of the specimens were retained; the other two are in the collection of the Kansas State College.

The larvae which were parasitized by this parasite grew to maturity and apparently pupated normally, but instead of an adult leaf roller emerging from the pupae, an adult parasite emerged. There were some indications that this species probably is a primary parasite of the leaf roller and that it in turn was parasitized by *Horiamenus microgaster* (Ashmead).

Clinocentrus sp. (Braconidae)

Three specimens of this species were reared from the strawberry leaf roller which came from Wamego, Kan., all of which are in the United States National Museum.

The larvae which were parasitized by this parasite did not reach maturity. They would cease growing and begin to shrivel at the ends and turn brown. The parasite emerged from this dried unshriveled middle portion. In other words, the old dried up larval skin of the host became the puparium of the parasite and in some cases the head and legs of the host larvae could be seen on the puparium after the adult parasite emerged.

Cremastus cookii Weed. 1888. (Ichneumonidae)

Temelucha cookii Ashmead.

Webster (*109*) reported this insect as a parasite of the strawberry leaf roller in Iowa. Lewis (*73*) just makes mention of it. Fink (*34*) says that fifteen percent of the larvae of the strawberry leaf roller in New Jersey were parasitized by this species. According to his observations its habit of parasitizing the host resembles that of *Macrocentrus ancylivora* Rohwer.

This was one of the more important species encounted during these studies. It appeared to be the predominating species in the vicinity of Leavenworth. All of the specimens except one came from that locality. Probably there were as many parasitized host larvae represented by this species as of any of the other species, as this species was solitary in habit while many of the others were gregarious.

Distribution: New Jersey (*34*); Ohio (*73*); Iowa (*109*).

Host:

Ancylis comptana Froel.

Oncophanes atriceps (Ashmead). (*5*). 1888. (Braconidae)

Rhyssalus atriceps Ashmead. Proc. U. S. Nat. Mus., 11, 628. 1888.
Oncophanes atriceps (Ashm). Annals, Ent. Soc. Amer., 28, 241-243. 1935.

Hough (*51*), while studying the biology of the red-banded leaf roller, found this species to be the most common parasite of this host. Frost (*39*) reported having reared it from the dusky leaf roller on several occasions.

This was the predominating species of parasites of strawberry leaf roller around Wamego and Manhattan. More specimens of this species were taken than any other during these studies. However, since several parasites usually live at the expense of a single host larva, no more larvae may have been parasitized by this species than some of the other species. Nine parasites were secured from one host larva. Lewis (*73*) secured ten specimens from one larva of a different host. Where this species was abundant the infestation of leaf rollers generally was on the decline; however, it was the second year of the infestation in these localities which may partly explain their effectiveness.

Distribution: Michigan (*60*); Ohio (*19*); Penn. (*38* and *39*); Virginia (*51*), and N. Y. (*72*).

Hosts:

Amorbia humerosana Clem.	Dusky leaf roller
Archips rosaceana Harris	————
Cacoecia rosaceana Harris	Oblique-banded leaf roller
Gelechia confusella Cham	Striped peach worm
Eulia velutiana Walk	Red-banded leaf roller
Ancylis comptana Froel	Strawberry leaf roller

Lewis (*73*) reared ten specimens from an undetermined host larvae, probably either *Playnota flavedana* Clem. or *Cacoecia paralellela* Rob.

Epiurus indagator (Cresson) (*22*). 1870. (Ichneumonidae)

Pimpla indagatrix Walsh. Trans. Am. Ent. Soc., 3, 146. 1870.
Pimpla indagatrix Walsh. Trans. Acad. Sci. St. Louis, 3, 141. 1873.
Scambus indigator Walsh. Psyche. 19, 97, 1922; and Proc. Ent. Soc., Nova Scotia, 8, 67. 1918.

In addition to these synonyms Dalls Tore (29a) lists:

Pimpla indigatrix Riley. Fourth Ann. Rept. Insects Mo., 48. 1872.
Pimpla indigatrix Provancher. Natural Canad., 12, 37. 1880.
Pimpla indigatrix Provancher. Faun. Entom. Canada Hymen, 460. 1883.

According to information from Cushman, the name "indagator" originated with Walsh, but Cresson was the first to publish it and to describe the species. Cresson is therefore the author.

Payne (*81*) and Hartzell (*50*) list this species as a pupal parasite. Johnson and Hammar (*65*), Porter and Garman, (*85*), Newcomer and Whitcomb (*79*), and Cushman (*28*) list it as a larval parasite. Cushman and also Porter and Garman say that oviposition takes place in the large or full-grown larvae and the parasite emerges from the host cocoon. Cushman further states: "This species is solitary; the cocoon consists of a thin silken lining to the burrow of the host." Balduf (*8*) gives a very interesting paper on the relation of this insect to a cynipid gall maker, *Disholcaspis mamma* (Walsh). Here he presents evidence to show that probably this insect requires a certain amount of plant tissue to balance the diet secured from its animal host, as is shown by a certain amount of feeding, just before pupation, on the gall of its host. Other authors are cited who concur in this opinion. He also brings out the possibility of a required alternate host and that when *D. mamma* is the host the parasite passes the winter as a larva in the host larva. McConnell (*74*) reporting on the parasites of the oriental fruit month, *Grapholitha molesta* Busck, in western Maryland, names two species of parasites of which *Epiurus indagator* is one, which are recovered in greater numbers than any others and says they have been reared from over-wintering larvae and observed throughout the season in limited numbers. Woods (*118*) discussing a fruit caterpillar, *Epinotia sp.*, "This insect was rather abundant in 1913, but was extensively parasitized which so reduced its numbers that it was quite rare in 1914 and had not appreciably reëstablished itself in 1915." This author gives some notes on the biology of this parasite and says that it is beyond doubt a larval parasite.

Only two specimens of this species were taken during these studies, and, while it is reported by Fink (*34*) as a parasite af the strawberry leaf roller, in neither case was it sufficiently abundant to be classed as of much importance.

Distribution: Canada (*8*), Missouri (*19*), N. J. (*34*), Colorado (*42*), Virginia (*51 and 74*), Michigan (*60*), Penn. (*17*), Ohio and N. Y. (*65*), Washington (*79*), and Nova Scotia (*81*), Conn. (*85*), Eastern half of United States and Southern Canada (*28*), Maine (*118*).

Hosts:

Mineola indigenella Zeller	———
Polychrosis viteana Clem	Grape-berry moth
Archips argyrospila Walk	Fruit-tree leaf roller
Notolophus antiqua L	Rusty tussock moth
Eulia pinatubana Kearfott	Pine tube moth
Hemerophila pariana (Clerck)	Apple and thorn skeletonizer
Gelechia confusella Chambers	Striped peach worm
Eulia velutinana Walk	Red-banded leaf roller
Carpocapsa pomonella L	Codling moth
Rhyacionia frustrana (Comstock)	Pine tip moth
Grapholitha molesta Busck	Oriental fruit moth
Phthorimaea glochinella Zell	———

Hosts—*Concluded.*

Phthorimaea operculella Zell	Potato-tuber moth
Ancylis comptana Froel	Strawberry leaf roller
Hemerocampa leucostigma S. & A	White marked tussock moth
Epinotia sp	Fruit caterpillar

Hoplocryptus incertulus Cushman.[4] (Ichneumonidae)

Hoplocryptus incertulus was first described by Cresson as *Cryptus incertus.* This name was preoccupied by *C. incertus* Ratz. "The name *incertulus* was devised by Viereck, but apparently was never published." Cushman (*27*) was the first to properly name the species and publish it.

Cryptus incertus Cresson (not Ratzenburg). Proc. Ent. Soc. Phil., 3, 306. 1864.
Phygadenon latus (Prov.). Dalla Torre. Catalogus Hymenopterorum., 3. 1901.
Itamplex incertulus Vier. Listed in Dalla Torre, but the paper seems to have been lost or was never published. (R. A. Cushman.)

Dunnam (*32*), McConnell (*75*), and Lewis (*73*) all reared this parasite from the strawberry leaf roller. McConnell (*75*) also states that it is a common parasite of this host and of the oriental fruit moth.

Six specimens of this species from all three localities were reared during these studies.

Distribution: Iowa (*32*), Maryland (*75*), Ohio (*73*), and Delaware (*106*).

Hosts:

Ancylis comptana Froel	Strawberry leaf roller
Grapholitha molesta Busck	Oriental fruit moth

Horismenus microgaster (Ashmead). (*4*). 1888. (Chalcididae)

Holcopelte microgaster. Ashmead (*4*). 1888.

All of the literature found which deals with this insect is concerning the catalpa sphinx, *Ceratomia catalpae* Bd. and its parasites. *Apanteles catalpae* Riley seems to be the predominating primary parasite and *Horismenus microgaster* Ashm. as a secondary parasite. In some cases the secondary parasite outnumbered the primary parasite four to one and it was thought that this secondary parasite prevented the primary parasite from being more effective in keeping the catalpa sphinx under control.

This species showed considerable evidence of being a secondary parasite and appeared to be parasitic on more than one of the other species obtained. The presence of this hyperparasite probably offers some explanation as to why parasites are not more effective than they are in holding the strawberry leaf roller in subjection. Apparently *Horismenus microgaster* was a hyperparasite on *Chroinaeus* n. sp. By a further study of the pupa cases from which this species emerged other hosts might be fairly definitely established, but this material was not available to the writer. This species was obtained from all three of the localities studied.

Distribution: Missouri (*4*), Ohio (*14, 15, 21*). This parasite probably occurs wherever the catalpa sphinx occurs, and Howard and Chittenden (*57*) give that as covering all of the United States from Texas and the Dakotas eastward.

Hosts:

Ceratomia catalpae Bd	Catalpa sphinx, indirect host
Apanteles catalpae Riley, direct host	————
Microgaster sp	————

4. Much of the information on this species has been supplied by Dr. Harold Morrison of the U. S. Nat. Mus. and his coworkers.

Meteorus trachynotus Viereck (102). 1912. (Braconidae)

Meteorus trachynotus Viereck. Proc. U. S. Nat. Mus., 42, 142. 1912.
Meteorus archipsidis Viereck. Proc. U. S. Nat. Mus., 43, 579. 1912.

Lewis (*73*) listed this species as a probable parasite of the strawberry leaf roller, *Ancylis comptana* Froel., having reared it from folded strawberry leaves. Dunnam (*32*) reared it from this host.

During these studies only one specimen of this species was reared from the strawberry leaf roller.

Distribution: Muesbeck (*77*); "Canada, New York, Pennsylvania, New Jersey, California, Colorado, Utah, Vancouver Island, Louisiana, Massachusetts, New Hampshire, Maine, Florida; probably occurs throughout the United States and at least southern Canada." In addition to this list it is recorded from Ohio (*73*) and Iowa (*32*).

Hosts:

Tortrix fumiferana Clemens	Spruce bud-worm
Archips argyrospila Walk	Fruit-tree leaf roller
Cacoecia argyrospila (Viereck)	Fruit-tree leaf roller
Ancylis comptana Froel	Strawberry leaf roller
Ania limbata Harv	————
Ancylis sp. and *Wilsonia* sp	————

Microbracon gelechiae (Ashmead). (*5*). 1888. (Braconidae)

Muesebeck (*78*) listed the following synonyms:

Bracon gelechiae Ashmead. Proc. U. S. Nat. Mus., 11, 623. 1889 (1888).
Bracon notaticeps Ashmead. Proc. U. S. Nat. Mus., 11, 624. 1889 (1888).
Bracon sp. Riley and Howard. Insect Life, 2, 349. 1890.
Habrobracon gelechiae Johnson. Ent. News, 6, 324. 1895.
Bracon sp. Johannsen and Patch. Maine Agr. Exp. Sta., 195, 243. 1912.
Habrobracon johannseni Viereck. Proc. U. S. Nat. Mus., 42, 622. 1913.
Habrobracon tetralophae Viereck. Proc. U. S. Nat. Mus., 42, 623. 1913.
Habrobracon gelechiae Cushman. Proc. Ent. Soc. Wash., 16, 106. 1914.
Habrobracon johannseni Cushman. Proc. Ent. Soc. Wash., 16, 107. 1914.
Habrobarcon gelechiae Stearns. Jour. Econ Ent., 12, 348. 1919.

Graf (*46*) listed this species as first in importance in 1914, but as fifth in 1915 as a parasite of the potato tuber moth. He also gives some information on the biology of this insect. Stearns (*91*) records, for the first time, this insect as a parasite of the oriental fruit moth and says that it attacks this host in the larval stage. Howard (*56*) calls attention to a very interesting discovery of Mr. B. Trouvelat with regard to the way this species feeds on the body fluids of the larvae of the potato tuber moth. Porter and Garman (*85*) reported this species as a larval parasite of the apple and thorn skeletonizer and they say these larvae collapse before reaching maturity. Cushman (*28*) classed it as a larval parasite of the pine tip moth, and adds that it is gregarious. Poos and Peters (*83*) give a list of native parasites for Virginia and this species heads the list. In 1928 Poos (*84*) reported this species as the most important parasite of the potato tuber moth during the early part of the year, while another parasite became more important in the latter part of the year. Flanders (*35*) found the larvae of the lima bean pod borer to be 5.3 percent parasitized while the same host was 40 percent parasitized on wild pea by this parasite.

This parasite did not seem to be of much importance as a parasite of the strawberry leaf roller at the places and during the time these studies were made. Only six specimens were reared, but this seems to be the first time that it has been recorded as a parasite of this host.

Distribution: Throughout United States; several foreign countries.

Hosts:

Galechiae sp. (Ashmead)	————
(*Gelechiae*) *Phlhorimaea cinerella* Murtfeldt (Ashmead)	Oak-leaf skeletonizer
(*Tetralopha*) *Wanda baptisiella* Fernald (Viereck)	Four spotted oak-leaf tyer
(*Gelechia*) *Aristotelia roseosuffusella* Clemens (Riley and Howard)	————
Canarsia hammondi Riley	————
Pyrausta nubilalis Hubner	European corn borer
Grapholitha molesta Busck	Oriental fruit moth
Gelechia hibiscella Busck	————
Phthorimaea operculella Zeller	Potato tuber moth
Papaipema sp. (in pinks)	Common stalk borer
Desmia funeralis Hubner	Grape-leaf folder
Polychrosis viteana Clemens	Grape-berry moth
Archips argyrospila Walker	Fruit-tree leaf roller
Hemerophila pariana (Clerck)	Apple and thorn skeletonizer
Rhyacionia frustrana (Comstock)	Pine tip moth
Phthorimaea glochinella Zell	————
Bedellia somnulentella Zell	————
Diatraece zeacolella Dyar	————
Etiella schisticolor Zeller	Legume pod moth
Ancylis comptana Froel	Strawberry leaf roller

Microbracon politiventris (Cushman). (*25*). 1919. (Braconidae)

Habrobracon politiventris Cushman. Proc. U. S. Nat. Mus., 55, 517. 1919.

According to Muesebeck (*78*), "The parasite is gregarious, several individuals developing on a single host." There seems to be nothing in the literature on this insect as to its economic importance.

Seven specimens of this species were reared during these studies. These were fairly evenly divided between the three localities studied.

Distribution: "From Maine to Virginia and west to Iowa," Muesebeck (*78*). Cushman (*25*) gives northeast Pennsylvania as the type locality.

Hosts:

Polychrosis viteana Clemens	Grape-berry moth
Eulia triferane Walker	————
Archips paralella Robinson	————
Pandemis lamprosana Robinson	————
Conotrachelus nenuphar Hbst	Plum curculio
Grapholitha molesta Busck	Oriental fruit moth

Microgaster comptanae Viereck (100). 1911. (Braconidae)

Lewis (*73*): "This parasite was taken in the fall of 1923 and was common throughout the season of 1924. It was also reared from the over-wintering generation and was taken from both larvae and pupae . . ."

Only four specimens of this species were taken, three from Wamego and one from Leavenworth.

Distribution: Ohio (*73*) and Colorado (*100*).

Hosts:

The strawberry leaf roller, *Ancylis comptana* Froel., was the host from which the type specimen was reared and no other host has been recorded.

Perisierola sp. (Bethylidae)

Four specimens of this species were reared from the strawberry leaf roller. They did not seem to respond so well to the methods used in these studies as did the other species. The pupa cases were thin, and the mortality was rather high.

Pleurotropis sexdentatus (Girault). 1916. (Eulophidae)

Pseudacrias sexdentatus Girault. Societas Entomolgica, Zurich., 31, 36. 1916.

Lewis (*73*), "*Pleurotropis sexdentatus* Gir.: as high as seven specimens were reached from a single leaf roller. It is possible that this may be a hyperparasite." Fink (*34*) placed this insect in a list of the lesser important parasites of the strawberry leaf roller, the more important ones having been discussed separately.

Fourteen specimens of this species from all three localities were reared during these studies. Several specimens emerged from a single host, sometimes a pupa of the leaf roller and sometimes from a white, typical parasite cocoon. At the time this work was done this species was confused with *Horismenus microgaster* (Ashm.) and may account for the difference in the host, but it was thought at the time that they were secondary parasites, though no definite proof was secured.

Distribution: Ohio (*73*), New Jersey (*34*).

Hosts:

Ancylis comptana Froel.......................... Strawberry leaf roller
Gnorimoschema gallaesolidaginis Riley.............. Goldenrod gall maker

These are probably secondary hosts and some other parasite larvae serve as primary hosts.

Spilochalcis albifrons (Walsh). 1861. (Chalcididae)

Dalla Torre (*29b*) gives the following synonomy:

Chalcis albifrons Walsh. Trans. Ill. State Agr. Soc., 4, 37. 1861.
Chalcis albifrons Riley. 2d Ann. Rpt. Insects of Mo., 52. 1870.
Smicra albifrons Cresson. Trans. Amer. Ent. Soc., 4, 39. 1872.
Chalcis albifrons Thomas. 10th Rpt. State Ent., Ill., 40. 1888.
Spilochalcis albifrons Howard. Descriptions North American Chalcidae, 7. 1885.

There is very little in the literature on this insect as to its economic importance. Dunnan (*32*) stated that he reared it from the strawberry leaf roller and that the pupal stage of this parasite lasted from five to nine days.

Only one specimen of this species was reared during these studies and that was from material collected at Wamego.

Distribution: Conn. (*10*), Tenn. (*45*), and Iowa (*32*).

Hosts:

Heliophila unipuncta Haw......................... Army worm
Apanteles militaris Walsh......................... ———
Ancylis comptana Froel.......................... Strawberry leaf roller

Sympiesis n. sp. (Eulophidae)

Only one specimen of this species was reared during these studies, which was retained by the U. S. National Museum.

Nemorilla floralis Fallen. 1820. *(Tachinidae)*

Fallen. Monographia Muscidum, Diptera Sveciae, vol. 2, p. 86; 1820.

Aldrich and Webber (*3*) give the following synonomy:

Tachina maculosa Meigen. Syst. Beschr. Zweifl. Ins., vol. 4, p. 266; 1824.

Nemorilla maculosa Rondani. Dipt. Ital. Prod., vol. 3, p. 101; 1859. Brauer and Bergenstamn, Zweifl. Kais. Mus., pt. 4, pl. 1, fig. 12, 1889; pt. 5, p. 328, 1891.

Tachina pyste Walker. List. Dipt. Ins., vol. 4, p. 754; 1849.

Tachina (Exorista) phycitae LeBaron. Second Rpt. State Ent. Ill., p. 128; 1872.

Exorista scudderi Williston, in Scudder's Butterflies of New England, vol 3, p. 1921; 1889.

Exorista pyste Coquillett. Revision Tachin., p. 93; 1897. Greene. Proc. U. S. Nat. Mus., vol. 60, p. 11; 1922, fig. 34, puparium. Reinhard. Ent. News, vol. 30, p. 281; 1919.

Titus (*96*), speaking of the sugar-beet crown-borer, *Hulstea undulatella* Clemens, says many of the larvae or pupae were parasitized by this parasite. Chittenden and Marsh (*18*), "*Exorista pyste* Walk. . . . has been repeatedly reared from the caterpillar of *Hellula undalis* (Imported cabbage webworm) from July 27 to as late as October 27." Walden (*105*) reports that 18 out of 53, or 34 percent of the larvae of *Archips rosana* L. were parasitized by this parasite. Strauss (*90*) reporting on the grape-leaf folder says that fly parasites were taken only in small numbers, but lists this one as the most abundant. Turner, Spooner and Chittenden (*98*) reporting on the pecan nut case-bearer, *Acrobasis hebescella* Hulst, "The natural enemies of this species appear to control it more efficiently than is the case with any other important insect attacking pecans." They further state that in 1916 25.5 percent of the larvae of the first generation were detroyed by *E. pyste* Walk. and that the second generation was much less abundant than the first. They rate it as being the most important enemy of the nut case-bearer. Gill (*44*) reporting on the same host, "The most effective parasite is the Tachinid fly, *Exorista pyste* Walk., which was reared in large numbers from the larvae and is, no doubt, a very important factor in the natural control of this pest." Caffrey (*16*) reporting on the European corn borer, says that a small percent of the larvae were parasitized by three flies and gives *E. pyste* second place in the list. He also discusses to some extent the biology of this fly. Vinal and Caffrey (*104*) reporting on the same host say that the percent of parasitism is very small but only dipterous parasites have been found and again list *E. pyste* in the second place. Felt (*33*) discussing the apple and thorn skeletonizer, *Hemerophila pariana* (Clerck), after rearing *E. pyste* Walk. from this host expressed hope that eventually native enemies will prove of considerable service in preventing the undue multiplication of this pest. Wilson (*115*) reports 12½ percent parasitism of the southern beet webworm, *Pachyzancla bipunctatis* Fab. by *E. pyste*. Harned (*49*) reported *N. maculosa* Meigen as doing effective work on *Pyraausta tyralis,* a budworm of dahlia. Leiby (*71*) working on the pecan shoot-borer, *Acrobasis caryae* Grote, lists three species of parasites and says of these *N. maculosa* is by far the most common, as high as 30 percent of the pupae being parasitized by this species in some seasons. Lewis (*73*) gave the first report found of this species as a parasite of the strawberry leaf roller, *Ancylis comptana* Froel., and gives a description of the different stages of development. Fink (*34*) reports a parasitism of 5 percent of the strawberry leaf roller by *E. pyste* Walk. He also gives a description of the egg, the entrance of the larva into the host and other information on its biology. Aldrich and Webber (*3*) say, "The species has a voluminous literature in Europe."

Six specimens were reared from material collected at Wamego and one from material collected at Leavenworth. At the time these studies were carried on the writer was unable to distinguish between the two species of flies obtained and as far as was determined their method of parasitizing was the same. The larvae parasitized by either of these flies were easily discovered, due to the presence of the eggs on or near the head of the larvae. The larvae seemed to pupate normally and in a few hours after pupation the larva of the parasite would make a hole in the host pupa and come out and pupate, sometimes the pupa case of the parasite protruded from the hole in the host pupa.

Distribution: California (*96*), Connecticut (*70, 105, 12, 13, 85*), Colorado and New Mexico (*42*), Puerto Rico (*66*), D. C. (*90*), Florida (*43*), Michigan (*60*), Georgia (*98*), Massachusetts (*16, 37*), Texas (*86*), New York (*33*), Mississippi (*49*), North Carolina (*71*), Maryland (*75*), New Jersey (*111*), Nova Scotia (*112*).

Hosts:

Hulstea undulatella Clemens	Sugar-beet crown borer
Hellula undalis Fab	Imported cabbage webworm
Acrobasis carvae Grote	Pecan shoot borer
Archips argyrospila Walk	Fruit-tree leaf roller
Archips rosana L.	Privet leaf roller
Peronea minuta (Rob.)	Dry-bog fireworm
Pachyzancla bipunctalis Fab	Southern beet webworm
Desmia funeralis Hub	Grape lear roller
Acrobasis nebulella Riley	Pecan leaf case-bearer
Gelechia confusella Cham	Striped peach worm
Pyrausta nubilalis Hubner	European corn borer
Hemerophila pariana (Clerck)	Apple and thorn skeletonizer
Mineola indiginella Zell	Apple leaf crumpler
Pyrausta tyralis Gn	Budworm of dahlia
Arcobasis hebescella Hulst	Pecan nut case bearer
Ancylis comptana Froel	Strawberry leaf roller
Pilocrocis tripunctata Fab	Sweet potato leaf roller
Humenia facialis Cramer	Hawaiian beet webworm
Grapholitha molesta Busck	Oriental fruit moth
Cacoecia rosana (L.)	Currant leaf roller

Phorocera torticis Coquillett. 1897. (Tachinidae)

Neopales tortricis Johnson, according to Aldrich and Webber (3).

There is very little in the literature on this insect. Porter and Garman (*85*) say, "According to Wallingford the life history is similar to that of *Exorista pyste* (*Nemorilla maculosa* Meig.)." Greene (*47*) gives a technical description of the puparium. The rest of the literature deals with technical descriptions of the insect and records hosts and distribution.

Sixteen specimens of this species were reared during these studies which is more than twice as many as of *Nemorilla floralis*. This seems to indicate that at the time and places where these studies were made, *P. tortricis* was of considerable more importance than *N. floralis*. This appears to be the first time that this species has been reported as a parasite of the strawberry leaf roller. This is also the first time it has been reported from Kansas, though it has been reported from adjoining states. This is the farthest west it has been reported.

PARASITES REARED FROM *Ancylis comptana*

The following table summarizes the parasites reared during these studies:

HYMENOPTEROUS PARASITES.	Family.	Number specimens.	Locality.
Apanteles canarsiae Ashmead	Braconidae	6	Wamego
Brachymeria ovata (Say)	Chalcididae	1	Wamego
Casinaria infesta (Cresson)	Ichneumonidae	1	Manhattan
Chorinaeus, n. sp	Ichneumonidae	17	Leavenworth
Clinocentrus sp	Braconidae	3	———
Cremastus cookii Weed	Ichneumonidae	22	Leavenworth and Wamego
Oncophanes atriceps (Ashmead)	Braconidae	54	Wamego and Manhattan
Epiurus indagator (Cresson)	Ichneumonidae	2	Wamego
Hoplocryptus incertulus Cushman	Ichneumonidae	6	Wamego, Manhattan and Leavenworth
Horismenus microgaster (Ashmead)	Chalcididae	23	Wamego, Manhattan and Leavenworth
Meteorus trachynotus Viereck	Braconidae	1	Wamego
Microbracon gelechiae (Ashmead)	Braconidae	6	Wamego
Microbracon politiventris (Cushman)	Braconidae	7	Wamego, Manhattan and Leavenworth
Microgaster comptanae Viereck	Braconidae	4	Wamego and Leavenworth
Perisierola sp	Bethylidae	4	Leavenworth
Pleurotropis sexdentatus (Girault)	Eulophidae	14	Wamego, Manhattan and Leavenworth
Spilochalcis albifrons (Walsh)	Chalcididae	1	Wamego
Sympiesis, n. sp	Eulophidae	1	———
DIPTEROUS PARASITES.			
Nemorilla floralsis Fallen	Tachinidae	7	Wamego, Manhattan and Leavenworth
Phorocera tortricis Coquillett	Tachinidae	16	Wamego, Manhattan and Leavenworth

A portion of these parasites are in the United States National Museum and the rest are in the collection of the Department of Entomology of the Kansas State College of Agriculture and Applied Sciences.

Distribution: Vermont (*66*), New Jersey (*3, 81, 110*), Connecticut (*12, 85*), North Carolina (*9*), Missouri, Michigan, Massachusetts and Arkansas (*3*).

Hosts:

Archips cerasivorana Fitch	Cherry-tree ugly-nest
Peronea minuta Rob	Dry-bog fireworm
Mineola indiginella Zell	Leaf crumpler
Cacoecia argyrospila Walker	Fruit-tree leaf roller
Hemerophila perinna Clerck	Apple and thorn skeletonizer

SUMMARY AND CONCLUSIONS

During these studies twenty species of parasites were reared from the strawberry leaf roller. Eighteen of these were Hymenoptrous and two were Dipterous parasites. Two of these species are new to science. Nine of these species had previously been listed as parasites of this host and eleven are new host records. No literature was found that definitely placed any of these insects on record as occurring in Kansas, though the distribution of some of them was such that it would have been assumed that they did occurr there.

Some evidence has been presented to show that under Kansas conditions parasites do play a considerable part in keeping the strawberry leaf roller under control.

No one species appears to be dominant for the state, although one species may predominate in a locality, as was the case of *Cremastus cookii* Weed in the vicinity of Leavenworth.

Horismenus microgaster (Ashmead) and *Pleurotropis sexdentatus* (Girault) probably are secondary parasites and therefore hinder in the control of the strawberry leaf roller.

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Symposium on the Geology, Flora, and Fauna of "Rock City," A Proposed National Monument in Ottawa County, Kansas

W. H. SCHOEWE, W. H. HORR, CHARLES E. BURT, and L. D. WOOSTER

INTRODUCTION AND HISTORY OF PROJECT

W. H. SCHOEWE, Chairman, Committee on Natural Areas and Ecology, University of Kansas, Lawrence, Kan.

Since 1931 the Committee on Natural Areas and Ecology has been investigating areas in Kansas which, because of scenic beauty, geological interest and ecological reasons, should be preserved for posterity. The survey conducted in 1931 revealed numerous areas in Kansas which for one reason or another were worthy as being set aside for the general use and pleasure of the people. Chief among these areas is the one about three miles southwest of Minneapolis in Ottawa county. On April 2, 1936, at the meeting of the Academy held at Emporia, the committee reported that the area of concretions near Minneapolis was of such striking and geological interest to warrant it being set aside as a national monument. A sum of fifty dollars was granted the committee by the executive council of the Academy to further investigate the area. An additional fifty dollars was granted the chairman of the committee by the Graduate Research Committee of the University of Kansas to make a plane-table map of the concretions. These two grants are hereby gratefully acknowledged.

At the request of the chairman of the committee Dr. L. D. Wooster undertook the study of the bird and mammal life of the monument site, whereas Dr. Charles E. Burt studied the amphibian and reptile life. Dr. W. H. Horr was assigned the flora of the area, and the chairman, Dr. W. H. Schoewe, studied the geology and made a detailed plane-table map of the concretions. Each party worked independently. Several trips to the proposed monument site were made in connection with the geological and flora studies. The chairman of the committee was accompanied on his first trip by Dr. F. C. Gates. The results of these studies constitute the papers of this symposium and the official report on the Academy's National Monument project.

On June 26, 1936, and on January 6, 1937, the chairman of the committee sent a typed report, accompanied by photographs and maps, to Mr. A. E. Demarcy, acting director, National Park Service at Washington, D. C., calling the attention of the United States National Park Service to this unusually interesting locality, and invited the director to send one of the Park's regional representatives to visit the area to make an investigation with the hope that steps might be taken to establish here a new national mounment. The same report was sent on March 8, 1937, to each of the United States senators and representatives from Kansas at Washington, D. C., informing them of the action taken by the Academy's committee, and suggesting to them to help further the cause. Letters were immediately received from each of the Kansas delegation at Washington informing us of their willingness to coöperate with

the Academy to the fullest extent. Copies of letters sent by the Kansas delegation to Mr. Arno B. Cammerer, director of the United States National Park Service, were received by the chairman in which it was stated: "We should, however, like to join heartily in the request for the designation of this area as a national monument and it is our earnest hope that a field representative of your Bureau may make an investigation of the area at an early date in order that an appropriate recommendation may be made to the National Advisory Committee and to the Secretary of the Interior."

This, in brief, is the history of the Academy's National Monument project from the time of its inception to April 3, 1937.

The Committee on Natural Areas and Ecology hopes and urges that all interested persons and organizations will do whatever they can to help establish in Kansas its first national monument, and that they will write to the United States senators and representatives from Kansas at Washington in behalf of the project.

THE GEOLOGY OF "ROCK CITY"

W. H. SCHOEWE, University of Kansas, Lawrence, Kan.

LOCATION

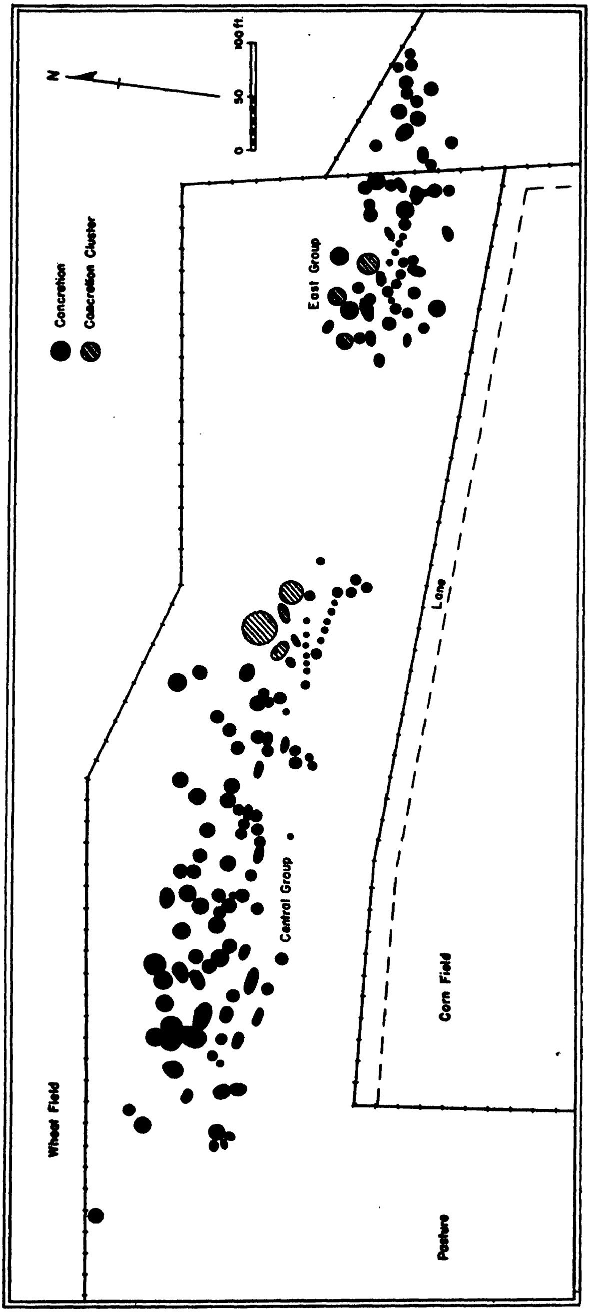
In the SW¼ sec. 14, T. 11 S., R. 4 W., about three miles southwest of Minneapolis, in Ottawa county, Kansas, is a group of Dakota sandstone concretions, locally known as "Rock City." (Fig. 1.) These concretions are especially distinctive for their size, number, shape, splendid details of cross-bedding which they contain, and accessibility. As far as is known, the area is not only strikingly unique geologically, but also is not duplicated anywhere else in the world.

GENERAL OCCURRENCE

The concretions occur in three distinct groups confined to an east-west elongated strip about 125 feet wide and 1,700 feet long. Topographically, this strip constitutes a gentle slope which leads down from the general upland bench of the Dakota sandstone to the flood plain of Solomon river to the north. A strip of cultivated farm land one tenth of a mile wide intervenes between the concretions and the east-west section-line road to the south. The entire plat of land between the section-line road and the flood plain, including the east and central group of concretions, is approximately twenty-seven acres. Similar groups of concretions, but fewer in number and of smaller size, occur two to three miles south of "Rock City" and also one half mile east of Lamar, about fifteen miles north and east of Minneapolis.

NUMBER AND SIZES

Maximum diameter in feet	*Number of concretions*	*Maximum diameter in feet*	*Number of concretions*
27	1	15	7
24	1	14	10
23	1	13	5
20	2	12	18
19	1	11	18
18	2	10	14
17	1	9	9
16	5	8	11



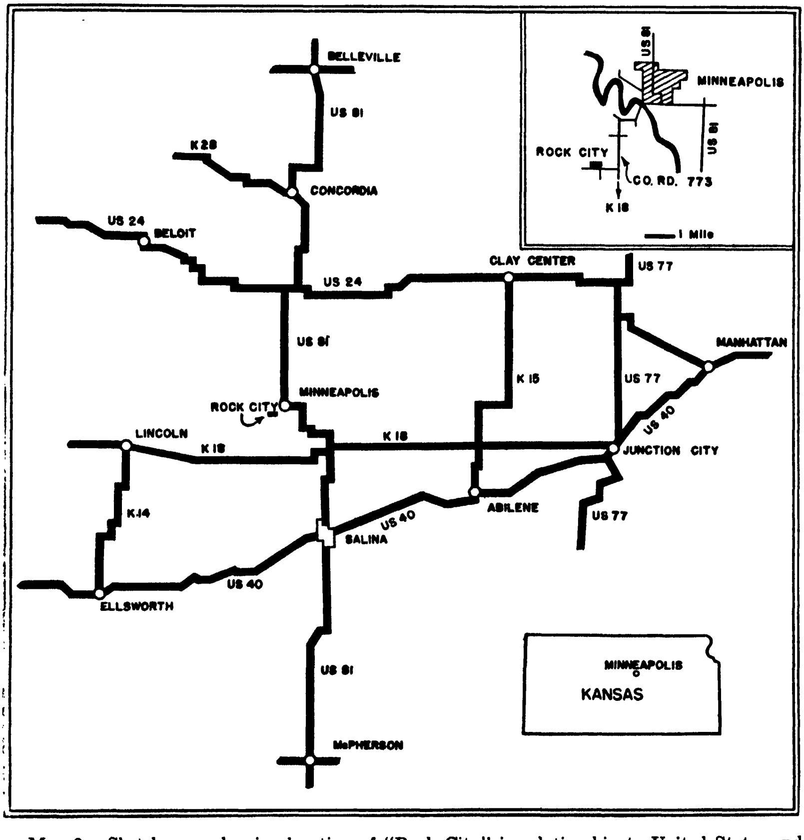
MAP 1.—Plane-table map showing number, relative sizes, and distribution of Dakota sandstone concretions of the east and central group at "Rock City."

NUMBER AND SIZES

At least 200 individual concretions occur in the three groups. In the east group are 52 concretions, in the central group at least 84, and in the west group approximately 70. The largest and best preserved concretions are found in the central and east group (Map 1). Many of the concretions in the west group are broken. Measurements were taken on over 100 individual concretions. On page 180 the table of the 101 largest concretions gives a summary of the maximum diameters in feet with the number of concretions belonging to each size.

SHAPES

The concretions are not only remarkable for their giant size and great number, but also for the many different shapes which they possess and for the splendid cross-bedding which they contain. As may be noted from figure 2, some of the concretions are practically perfect spheres; others, figure 3, are loaf-shaped, and still others, figure 4, have truncated tops. Other concretions are of irregular shape. Most of the concretions show excellent cross-bedding



MAP 2.—Sketch map showing location of "Rock City" in relationship to United States and Kansas highways, and in the insert the relationship to Minneapolis, Kan.

such as shown on figure 5. In addition, some of the concretions are characterized by special features such as the one illustrated by figure 6. Practically all degrees of uncovering of the concretions may be seen in the area. Some of the concretions are entirely exposed; others are partly imbedded in the Dakota sandstone, and in some only a small portion of the upper surface of the concretion protrudes above the ground.

ACCESSIBILITY

Not least important is the accessibility of "Rock City" to the traveling public. The proposed monument site lies about midway between U. S. highways 40 and 24. (Map. 2.) U. S. highway 40, passing through Kansas City, Lawrence, Topeka, Manhattan, Fort Riley, Junction City, Abilene, Salina, Ellsworth, Hays, Wakeeney, and Oakley, is the most traveled transcontinental highway passing in an east-west direction through Kansas. U. S. highway 81, extending north and south, is the main artery connecting Winnepeg, Canada, with San Antonio, Tex., and Mexico. This important traffic route passes through Minneapolis, Kan., only three miles northeast of "Rock City." From Minneapolis the area of concretions is reached by way of Ottawa county road No. 773, an all-weather road to one half mile east of the concretions. This last half mile is in the Dakota sandstone and is, therefore, sandy. The relationship between "Rock City" and the main U. S. highways is shown on map 2, and an insert shows the detailed location relative to Minneapolis.

WELL-KNOWN CONCRETIONS

The concretions have been known since at least 1878 (*1*) and photographs of them appear in Chamberlin and Salisbury's well-known and classic textbooks of Geology, "Geology, Vol. III, Earth History," figs. 393 and 394; "College Geology," fig. 506; and "Introductory Geology," fig. 453. Other illustrations of them appear in the reports of the Kansas State Board of Agriculture (*2*), figs. 5 and 6), newspapers (*3*), highway map (*4*), American Journal of Science (*5*), and Bulletin of the State Geological Survey of Kansas (*6*).

ORIGIN

The uniqueness of the concretions has aroused considerable speculation in regard to their origin. Locally, the concretions have been, and to a certain extent still are, considered as huge boulders brought down to their present location by a continental ice sheet. Others think of them as huge corals (*5*). Although recognized as early as 1878 (*1*) as concretions, no detailed description of their origin appears in the literature. Bell (*5*) describes the concretions as "concretionary masses of crystalline limestone, most of them still in place." Wooster (*7*) is of the opinion that the concretions should be classified as siliceous limestone bodies. Their spherical shape, he believes, is due chiefly to the shape of the bunches of calcium-carbonate depositing algae which are responsible for the concretions, and secondarily to erosive action of wind and water and to the solvent action of carbonic acid in rain water. Just how the concretions are formed is not clear from Wooster's mimeographed report, especially in view of his statement that "amorphous calcium carbonate incrusts the grains of sand that are washed in by the waves and before it is consolidated it becomes crystallized by diagensis."

The concretions at "Rock City" are unusually fine examples of concretions of epigenetic origin, a view also entertained by Landes (*6, 8*). They represent local areas within the Dakota sandstone where the sand grains have been cemented together more firmly than in the rest of the rock. Analyses show that the cementing material is calcium carbonate which was precipitated in the pores between the sand grains by circulating underground water. Why the cementation process was localized and why the material was deposited in more or less spherical fashion is not known. That the cementation process giving rise to the concretions was subsequent to the deposition of the Dakota sandstone, however, is indicated by the fact that the bedding planes and cross-bedding pass through the spherical masses. (Figs. 3 and 6.) The presence of the concretions at "Rock City" is due to the removal of the less well-cemented portions of the Dakota sandstone by ordinary processes of weathering and erosion by water and wind. Many of the concretions are completely weathered out of the sandstone; others are partly uncovered, whereas still others are for the greater part imbedded in the sandstone with only a very small portion of the upper surface protruding above the ground.

"ROCK CITY" WORTHY AS A NATIONAL MONUMENT

Because the concretions at "Rock City" near Minneapolis in Ottawa county, Kansas, are especially distinctive for their giant size, great number, varied shapes, all degrees of exposure, splendid details of cross-bedding which they contain, accessibility, and great geologic interest in portraying the work of circulating underground waters, weathering, differential erosion, and the formation of excellent type of cross-bedding, the Committee on Natural Areas and Ecology of the Kansas Academy of Science is firmly convinced that "Rock City" is of sufficient general and geologic interest to warrant it being set aside as a national monument. This is especially true in view of the fact that there is no similar area known in the world where all of the above features may be found in such a restricted area and so easily accessible to the traveling public. Furthermore, the area should be set aside for all time and for all people before the concretions are eventually disfigured and to a certain extent destroyed through acts of vandalism and thoughtlessness. The latter are best illustrated by the efforts on the part of some individuals to have the concretions crushed for road-building materials, others breaking off pieces of rock from the concretions, and others causing undue disintegration of part of the concretions by building fires in the cracks contained in the concretions or beneath their projecting masses. Disfiguration of the concretions is also due to the carving of initials on them on a wholesale scale.

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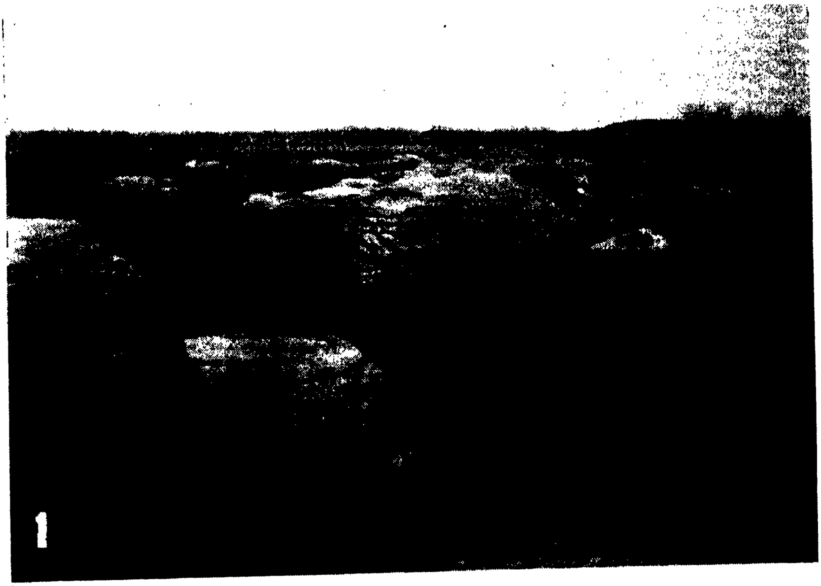
PLATE I

FIG. 1. General View of Concretions at "Rock City."

FIG. 2. Giant spherical concretion. Compare size with that of little girl 42 inches tall.

PLATE I



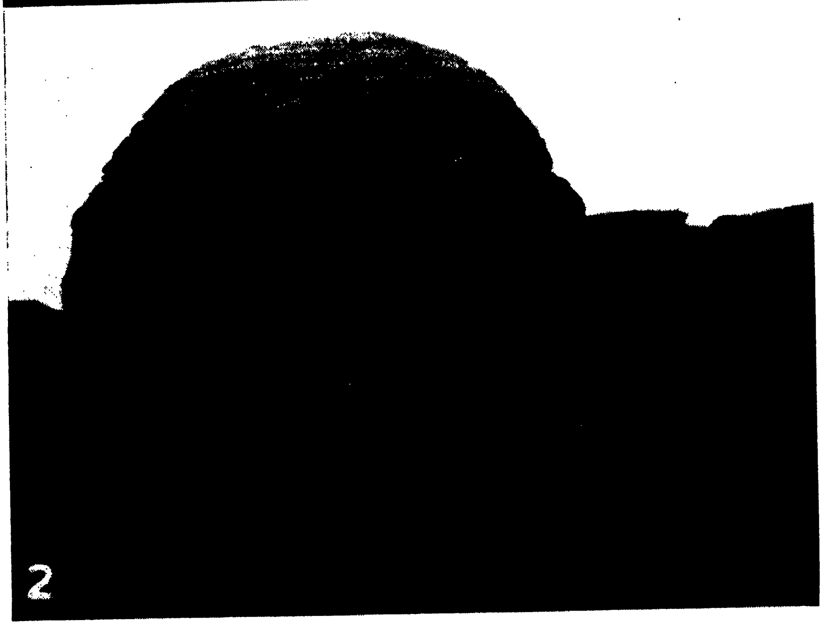
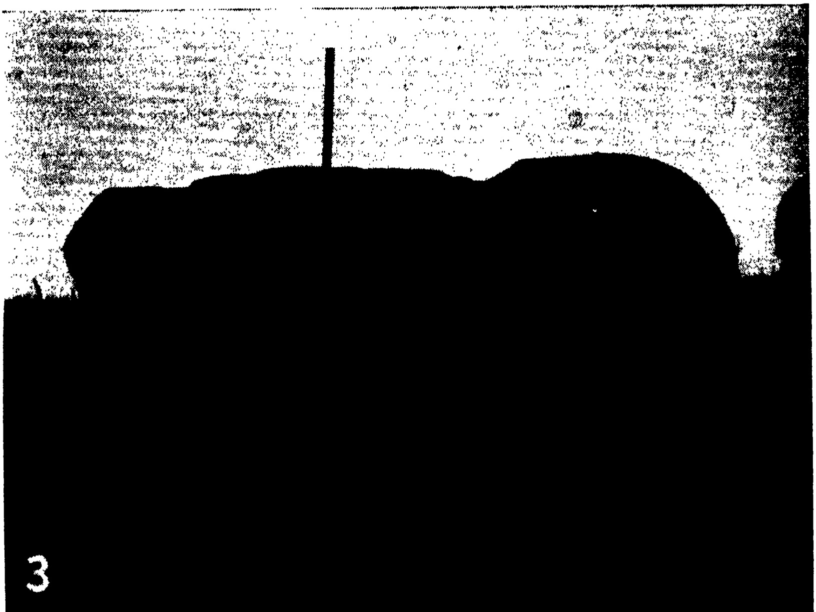


PLATE II

FIG. 3. Sugar-loaf shaped concretion. Rod 12 feet tall.

FIG. 4. Group of truncated concretions with base partly imbedded in Dakota sandstone. Rod 12 feet tall.

PLATE II



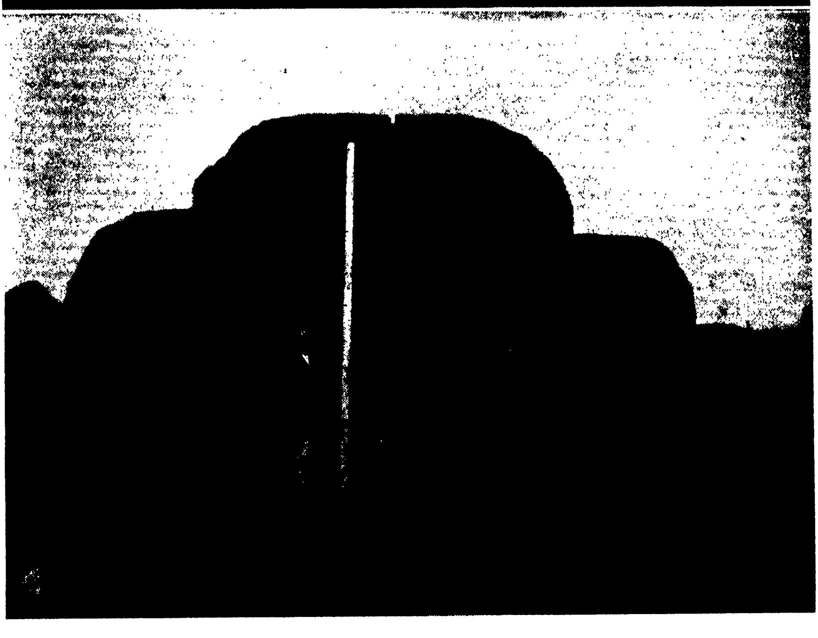
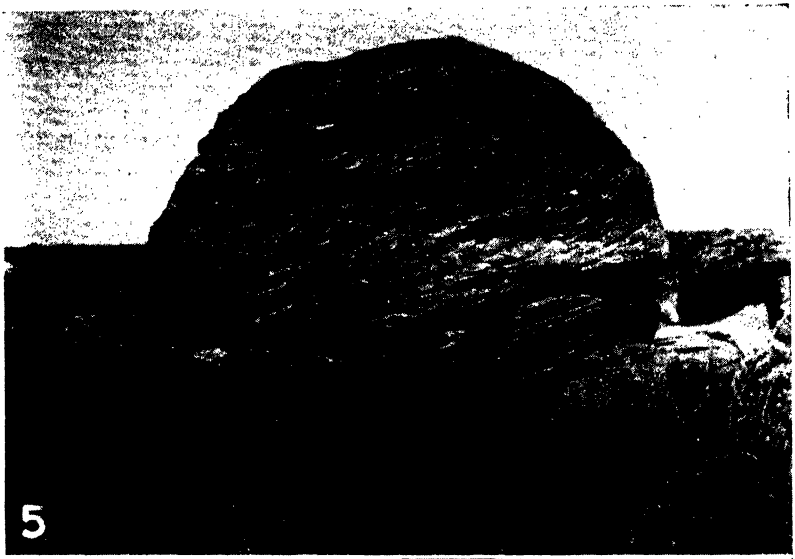


PLATE III

FIG. 5. Concretion showing typical cross-beding.
FIG. 6. Concretion with hollow center.

PLATE III



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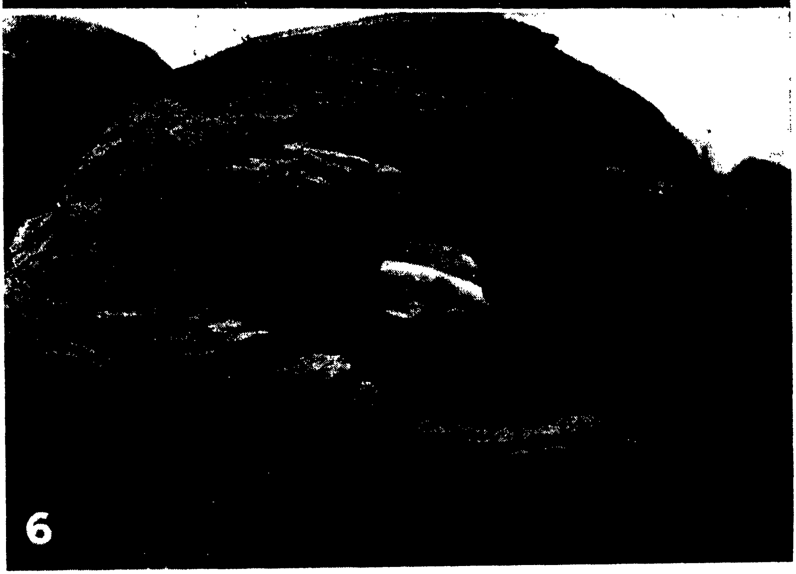

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THE FLORA OF "ROCK CITY"

W. H. HORR, University of Kansas, Lawrence, Kan.

The Rock City area lies in the so-called short grass mixed prairie region where grama and buffalo grasses form the predominating vegetation. The vegetation of this particular area, however, is quite varied for this region. This is probably due in part to the seeds introduced by the many automobiles driven in by visitors from various sections of the country, and in part to the protection against sun and wind, offered by the large concretions present.

Perhaps the most outstanding feature of the flora is the presence of at least two species of mosses, two of liverworts and two of ferns. These are plants normally associated with more humid regions.

As is general in this region, there are few trees present. A planting of some twenty catalpas has about run its course, and most of the trees are dead. In 1936 there was one Kentucky coffee bean seedling about two feet high and a small white mulberry tree growing among the large rocks. The shrub population was made up of several specimens each of smooth sumac, buffalo or Missouri currant, dogwood, and entirely too many specimens of poison ivy. The only other woody plant found was a wild grape.

The herbaceous plants show a seasonal variation with the grasses always predominating. In May, 1936, spiderworts, wild onions and hymenopappus, added gay colors to the green of the landscape and these were soon joined and followed by the deep red purple flowers of the poppy mallow. When I visited the place in early September, of the same year, after an extremely dry summer, the most prominent blossoms were those of the iron plant, sideranthus.

The following list of plants from this area is not complete and may not be correct in some cases as many of the identifications were made from immature plants or from fragments of dead plants found standing from the previous year. It includes some plants collected in "Rock City" by F. C. Gates in April and September, 1936.

PLANTS OF "ROCK CITY"

Bryophytes
- Two liverworts
- Two mosses

Pteridophytes
- Notholaena dealbata
- Pellaea atropurpurea

Gymnosperms
- None

Angiosperms
- Agrimonia parviflora
- Allium nuttallii
- Amaranthus sp.
- Ambrosia elatior
- Andropogon furcatus
- Andropogon scoparius
- Androsace occidentalis
- Anemone caroliniana
- Aristida oligantha
- Asclepias sp.
- Bouteloua curtipendula
- Bouteloua gracilis
- Bouteloua hirsuta
- Buchloe dactyloides
- Bromus purgans
- Callirrhoe involucrata
- Carex heliophila
- Catalpa speciosa
- Cenchrus pauciflorus
- Chenopodium album
- Chenopodium fremontii
- Chloris verticillata
- Cleome serrulata
- Cogswellia daucifolia
- Coreopsis tinctoria
- Cornus asperifolia
- Corydalis montana
- Croton capitatus
- Croton texensis
- Echinochloa crus-galli
- Elymus canadensis robustus
- Eragrostis cilianensis
- Eragrostis pectinacea
- Eragrostis secundiflora
- Eriogonum annuum

Euphorbia glyptosperma
Euphorbia maculata
Festuca octoflora
Froelichia gracilis
Gaura coccinea
Gaura parviflora
Gymnocladus dioica
Hedeoma hispida
Helianthus annuus
Helianthus petiolaris
Hordeum jubatum
Hordeum pusillum
Hymenopappus sulfureus
Isopappus divaricatus
Linum sulcatum
Mollugo verticillata
Morus alba
Oenothera serrulata
Opuntia humifusa
Oxalis violacea
Panicum capillare
Panicum sp.
Petalostemon sp.
Rhus glabra
Rhus toxicondendron
Ribes odoratum
Rumex altissimus
Salvia lanceolata
Setaria geniculata
Sideranthus spinulosus
Solanum rostratum
Solanum triflorum
Solidago glaberrima
Sporobolus asper
Tradescantia probably bracteata
Tradescantia tharpii
Verbena hastata
Vitis vulpina
Xanthium pennsylvanicum

On November 7, 1937, the following additional species were found by F. C Gates and party:

Argemone intermedia
Artemisia ludoviciana
Erigeron canadensis
Leptoloma cognatum
Oenothera strigosa
Physalis virginiana
Polygonum longistylum, and Zea mays.
Artemisia dracunculoides
Eragrostis trichodes
Kuhnia suaveolens
Liatris punctata
Panicum scribnerianum
Polanisia trachysperma

THE FAUNA: AMPHIBIANS AND REPTILES OF "ROCK CITY"

CHARLES E. BURT, Southwestern College, Winfield, Kan.

"Rock City" is primarily of interest because of its remarkable rock formations. The immediate vicinity is dry and relatively barren and only the herpetological species that are tolerant of such conditions occur there. Among these are the following: *Terrapene ornata* (box turtle), *Holbrookia maculata maculata* (spotted earless lizard), *Phrynosoma cornutum* (horned "toad"), *Cnemidophorus sexlineatus sexlineatus* (six-lined race-runner), *Eumeces obsoletus* (gray skink), and *Coluber constrictor flaviventris* (blue racer snake), and *Pituophis sayi sayi* (bullsnake), which were observed on field trips to the area in the spring and summer of 1936.

THE FAUNA: MAMMALS AND BIRDS OF "ROCK CITY"

L. D. WOOSTER, Fort Hays Kansas State College, Hays, Kan.

A survey of the mammals and birds of "Rock City" in Ottawa county, Kansas, was made on June 12 and 13, 1936, under the direction of L. D. Wooster, with the assistance of Henry Mooney, F. W. Albertson and Earl Bondy—all of the Fort Hays Kansas State College, Hays, Kan.

The weather at the time of the survey was clear and in the neighborhood of 100° F. in the shade during the day. The time spent on the area was the afternoon and night of June 12 and part of the morning of June 13. Two members of the surveying party camped out among the rocks for the night.

The survey of birds was made by observation, by traveling over the area, by remaining quiet at inconspicuous points of observation, and by nests. The number and kinds of birds actually seen on the area were:

Crow, *Corvus americanus* (Aud.)	3
Mourning dove, *Zenaidura macroura* (Linn.)	4
Lark sparrow, *Chondestes grammacus* (Say)	2
Cliff Swallow, *Petrochelidon lunifrons* (Say)	6
Arkansas Kingbird, *Tyrannus verticalis* (Say)	1
Western Grasshopper sparrow, *Ammodramus savannarum bimaculatus* (Swains)	9
Sparrow sp? (streaks on breast)	1
Orchard Oriole, *Icterus spurius* (Linn.)	1

The crows flew away from the area at the time of our arrival. There were old crow nests in some of the catalpa trees of the area. Mourning doves occasionally flew into the area and out again. No nests were found. A pair of lark sparrows was found nesting in a crevice in one of the concretions. There were four eggs in the nest. Cliff swallows were seen flying about the area several times, but no nests could be found. One Arkansas kingbird was seen in one of the catalpa trees. Western grasshopper sparrows seemed to be the most numerous species on the area, but especially numerous at the far west end beyond the enclosure in which most of the rocks are located, where the grass was taller than in the main area. One specimen of an unidentified species of the sparrow was seen. An orchard oriole flew into the place and out again.

Birds seen near the area (within one mile), but not actually on it, and yet, birds which in all likelihood are on it at times were:

Dickcissel, *Spiza americana* (Gmel.)
Western meadow lark, *Sturnella magna neglecta* (Aud.)
Horned lark, *Otocoris alpestris leucolaema* (Coues)
Quail, *Cyrtonyx montezumae mearnsi* (Nelson)
Killdeer, *Aegialitis vocifera* (Linn.)
Nighthawk, *Chordeiles virginianus* (Gmel.)
Golden flicker, *Colaptes auratus luteus* (Bangs)
Baltimore oriole, *Icterus galbula* (Linn.)
Nests seen:
Crow (old nests, not occupied)

Lark sparrow (eggs in the nest and bird incubating). (Fig. 1.) The nest was in a crevice of one of the large concretions at about the height of a man's head.

A survey of the mammals was made by traveling over the area, by observation from inconspicuous places, especially at dusk, by trapping, by evidences such as mounds, tunnels, etc., and by consultation with men familiar with the area. Mammals actually seen on the area were:

Cottontail, *Sylvilagus floridanus mearnsi* (Allen) 5
Thirteen-lined ground squirrel, *Citellus tridecemlineatus pallidus* (Allen) 1
White-footed mouse, *Peromyscus maniculatus nebrascensis* (Coues) 5

Indications only: A few mounds of Pocket Gophers were found especially along the lower north side of the area. One fresh mound was found, (fig. 2). More tunnels were found along the lower side of the area.

Two men, who were familiar with the area for many years were interviewed: Ralph G. Hemingway, editor of the Minneapolis *Messenger,* and Doctor Goodwin, a dentist, who had hunted over the area in the past and who had been especially interested in protecting and preserving it.

These men reported that, the following mammals had been seen on the area: Coyotes, *Canis nebrascensis nebrascensis* (Merriam) and skunks, *Mephitis mesomelas varians* (Gray) both of which had been known to den on the area. Raccoons, *Procyon lotor lotor* (Linn.), opossums, *Didelphis virginiana virginiana* (Kerr), and black-tailed jackrabbits, *Lepus californicus melanotis* (Mearns) had all been found on the area in former times, but trapping, hunting, and the influx of visitors had eliminated them.

Outside the area there were seen the following mammals: One harvest mouse, *Reithrodontomys albescens griseus* (Bailey), nine miles away, Black-tailed jackrabbits, *Lepus californicus melanotis* (Mearns).

It is very likely that mammals and birds other than those mentioned are at times to be found on this "Rock City" area. In all likelihood, other species of mice, for example, are on the place. The meadow mouse, ordinarily abundant in Kansas, has been eliminated from most of the western half of the state during the drought of the last three years. It is quite likely that shrews could be found on the area, but one night of trapping would be insufficient to reveal them.

It would be strange if one or more species of owls were not to be found in and around the area at times. The same is true of hawks.

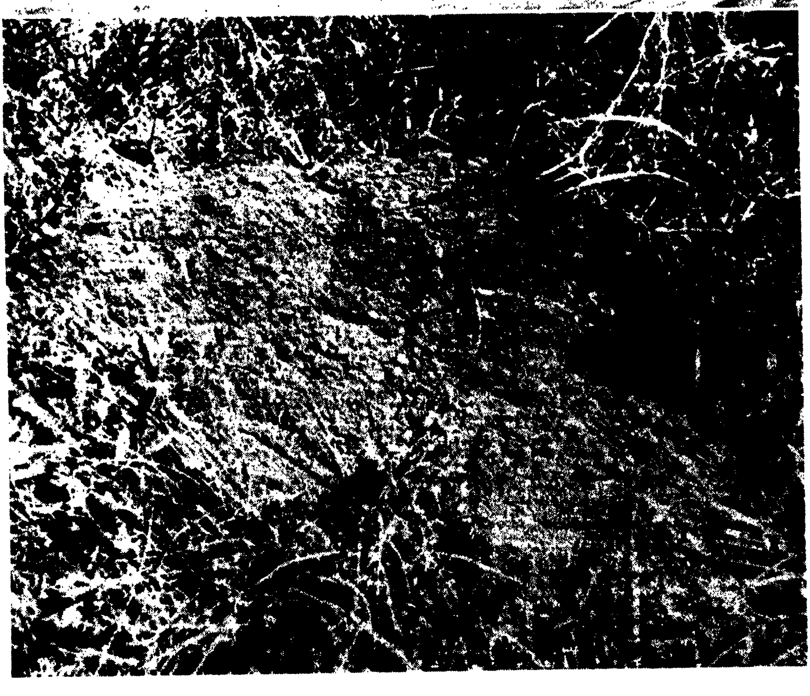
If the area were made into a national monument or a state park, in fact, whether it were or not, the large mammals such as the coyote, the skunks, etc., would probably seldom, if ever, return. The planting of trees would encourage and increase the bird life.

PLATE IV

FIG. 1. Lark sparrow nest in crevice in a concretion. The female bird was incubating four eggs.

FIG. 2. A pocket gopher mound, freshly made.

PLATE IV



Ground Cover Affects Frost Penetration [1]

R. J. BARNETT, Kansas Agricultural Experiment Station, Manhattan, Kan.

Many phases of the relation between low atmospheric temperature and the soil have been studied and data or observations recorded. These records show that the soil freezes from the surface downward; that the soil constituent which actually freezes is the soil water; that the water which first freezes is that in the soil interstices, followed by that which surrounds the soil particles as molecular envelopes; that this water freezes in the form of long, needlelike crystals, and that these may coalesce to form ice masses, sometimes several inches in diameter.

That these ice crystals and ice masses exert tremendous crystallizing force has long been known. Lyon, Fippin and Buckman in "Soils" state that when one cubic foot of water changes to ice the crystallizing force is about 150 tons. This freezing and the subsequent thawing break up soil masses and have a granulating effect on the soil particles, through which the physical condition of the soil is improved for crop production. If repeated frequently the alternate freezing and thawing of the surface soil may do much damage to crops and seedling trees through heaving. Low temperatures in the soil may also cause severe root injury to fruit plants. In fact, this is among the important environmental factors which determine the adapatation of the various kinds and varieties of fruit in the temperate zone.

The above sketch indicates part of the background which led to the studies recorded in this atricle. Beginning in the winter of 1934-'35 data regarding frost penetration into orchard soils under various methods of surface treatment have been collected. The general story told by these studies was consistent for the years 1935 and 1936 even though the more severe weather of the second year forced the frost to much greater depths than in 1935. Reports of frozen water pipes in 1936 indicate that not for many years had the soil been frozen so deeply. The record for the winter of 1936-'37 varied in several ways from that of other years and will constitute the present report.

METHODS OF THE STUDY

Six sites for record taking were located in January, 1937. These sites were chosen on the basis of the condition of the surface soil and the ground cover on the soil. The soil on which these stations were located shows in profile a brown horizon A about six to eight inches deep. Horizon B is a compact clay, reddish-brown in color.

Site 1. This soil was bare of ground cover and was compact to the surface. Located on a roadside.

Site 2. Soil bare, compact and under a layer of snow four inches in thickness. Near site No. 1.

Site 3. Soil bare, surface cultivated. A common condition of orchard soil.

Site 4. Soil bare, surface cultivated and under a layer of snow four inches in thickness.

Site 5. Soil cultivated until September 15 when winter vetch was sown. Only a light growth was made during the fall.

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1. Contribution No. 147, Department of Horticulture, Kansas State College.

Site 6. Soil not cultivated, but loose and covered by a layer of settled wheat straw three inches in thickness.

The penetration of the frost into the soil under those varying conditions was determined by exposing a soil profile about one foot wide and as deep as the frost had penetrated. The determination of the deepest frost and, later, the upper line as the frost withdrew could not be done with greater accuracy than one-fourth inch because of irregularly distributed ice masses. These measurements were made on thirteen dates beginning January 12 and ending March 3. These dates were chosen because weather conditions indicated that change might be occurring in the frost penetration. Measurements were made for all the stations on the same date. Mean daily temperatures for the same period of time were recorded.

The graphs shown in figures 1 to 6 illustrate the penetration of the frost into the soil and its retreat during the period January 12 to March 3, 1937. As shown in figure 1 the lower line of the frost became deeper in the compact soil of this site and under the continued low temperature until February 6 when the maximum depth was reached at about the twenty-two inch level. From that date on the ice slowly melted from below and disappeared by March 2 at which time a new layer of frozen soil had formed above it to a depth of nearly ten inches. Melting of the ice from above on this site began on February 11, deepened rapidly until February 14, slowly until February 22 and rapidly again until its disappearance, March 2.

Figure 2 shows the movement of frost in bare compact soil under a layer of snow four inches in thickness. This graph is similar to that shown in figure 1, but is very different from the usual behavior of frost in snow-covered soil. In former years a layer of snow acted as a blanket, and both retarded and lessened penetration of the frost into the soil. This year's snow cover was more nearly a sheet of ice and did not exert the ameliorative effect associated with a layer of loose snow. The melting from above of ice in the soil was somewhat retarded by the layer of snow.

Site 3, on which the surface of the soil entered the winter in a loose, cultivated condition, resembles a common state in orchard soils, and is usually associated with less severe freezing than occurs in soil which is compact to the surface. The graph in figure 3 indicates that this protective influence was slight during the past winter. However, the frost did not penetrate so deeply as in the compact soil, and the retreat of the frost from both above and below was more rapid. The behavior of the freeze of February 24 to March 2 on this site was peculiar.

Figure 4 shows the course of the frost on a site similar to that illustrated by figure 3 except this one was under a layer of snow or ice four inches in thickness. Apparent effects of the ice were slightly deeper penetration of the frost and a smoothing effect on the low points. No significant differences in the section of the graph showing the disappearance of the ice appear.

In the former years when conditions favored the growth of a cover crop of winter vetch during the fall and early winter the resulting mat of vegetation has strikingly ameliorated the action of the frost later in the winter. The meager growth of this cover crop last fall did not serve as protection on site number 5. The graph, figure 5, shows nearly the same outline as those obtained in soils which were bare of vegetation. The slightly deeper penetra-

tion of the frost, about 2 inches, was probably due to some cause other than the presence of the cover crop. This site was practically free from snow and ice.

The contrast between the graph shown in figure 6 and the others in this series is striking. As stated previously the soil of this site was covered by a layer of settled wheat straw three inches in thickness. The great insultating value of this mulch is shown in two ways: First, the maximum penetration of the frost was only 3¼ inches or about fourteen percent of the penetration into bare soil. Second, variations in the depth of the frost during the cold periods were very slight. It is also of interest that the frost under the straw mulch thawed wholly from below.

A few general conclusions may be drawn from the observations recorded in this article. 1. The lag between a change in the temperature of the air and the response of the frost in the soil is shown. 2. A blanket of compacted snow or ice does not lessen the penetration of the frost into the soil as a layer of loose snow does, as shown by previous observations. 3. The efficacy of a straw mulch in preventing deep freezing of the underlying soil is demonstrated. 4. Under the influence of higher air temperature the thawing of the soil takes place from both the surface and the lower face and continues at nearly the same rate upward and downward. 5. Except for the straw mulch site, surface condition of the soil caused only slight variations in the depth of penetration and the profile of the frozen soil during the winter of 1936-'37.

PLATE I

GROUND COVER AFFECTS FROST PENETRATION—1937

FIG. 1. Penetration of frost. Surface soil bare and compact.

FIG. 2. Penetration of frost. Surface soil compact but under a layer of dense snow.

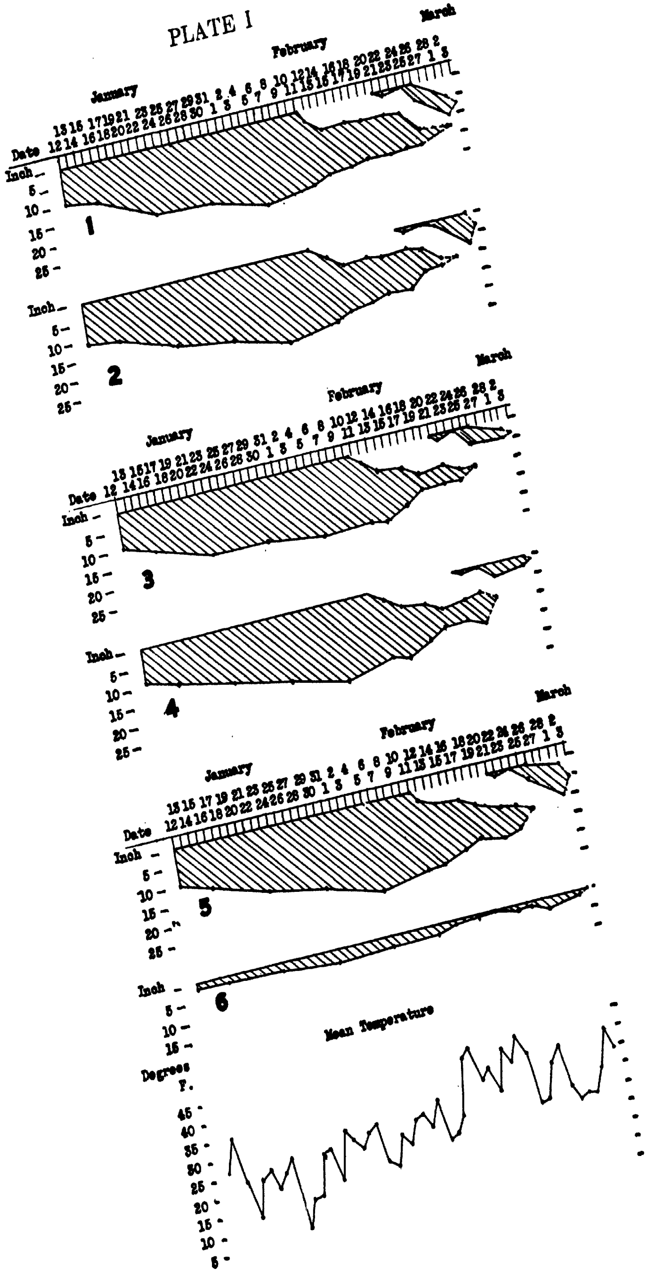
FIG. 3. Penetration of frost. Surface soil bare and cultivated.

FIG. 4. Penetration of frost. Surface soil cultivated and under a layer of dense snow.

FIG. 5. Penetration of frost. Surface soil covered by a light growth of winter vetch.

FIG. 6. Penetration of frost. Surface of the soil covered by three inches of compact straw.

PLATE I



Coöperation Among Kansas Scientists

W. J. BAUMGARTNER, University of Kansas, Lawrence, Kan.

Dr. J. McKeen Cattell in the first edition of his book "American Men of Science," 1906, used the following language: "There scarcely exists among scientific men the recognition of common interest and the spirit of coöperation which would help to give science the place it should have in the community. It is fully as important for the nation as for men of science that scientific work should be adequately recognized and supported. We are consequently in the fortunate position of knowing that whatever we do to promote our own interests is at the same time a service to the community and the world."

There was a great increase in the appreciation of science in the following three decades. So the same author in his call for the new 6th edition of "American Men of Science" could say, "The 22,000 scientists listed in the 1933 edition have probably done more for the welfare of the American people than all the business of New York and all the political leaders in Washington."

Business and political leaders would most likely vehemently deny such an inference at present and certainly would have done so at the time the earlier editions of Cattell's book. But speaking from the standpoint of the nation extensive progress has been made both in the coöperation among scientists and in the recognition granted scientific work by business and government. Among the means which have brought about this very marked progress have been Cattell's five editions of "American Men of Science." As an evidence of the greater coöperation among scientists may be cited the growth of the American Association for the Advancement of Science.

In 1906 the Association had a membership of 4,400, divided into 10 sectional groups. There were sixteen affiliated societies. The American Association now (1936) has 18,000 members residing in the United States, Canada and Mexico and in nearly sixty other countries. Associated or affiliated with it are more than 150 other scientific societies with a total net membership of more than 500,000. This "triple A. S.," as we call it, has fifteen sections, representing all the principal subdivisions of pure and applied science, including social, economic, historical and philological science and education. It thus covers the whole field of science and the whole body of scientists.

The influence yielded by this great group of men is proven by the interest the public is showing in the annual meetings as evidenced by the lengthy reports in the outstanding national newspapers. That business is vitally concerned with the results of the work of scientists is factually attested by the operation of more than 1,600 research laboratories by industrial companies. They use scientists to solve their knotty problems.

The public press recently spread the news that the one business organization which had increased its rate of dividends during the depression, doubled its research staff at the beginning of the hard years. Another buiness firm which kept its staff *in toto* never missed a dividend although it reduced some of them. On the other hand practically all the firms which dismissed research departments had to stop their dividends. As these results are more appreciated among the various firms in the buiness and governmental world we can and do expect a much more extended employment of scientists in business and governmental positions.

With such thoughts in the back of his mind the writer has in the past few years suggested and urged the building up of a coöperative organization among the scientists in the state of Kansas. He has recently made a partial survey of the local scientific organizations covering Kansas. He can tabulate the following results, which came mostly as answers to a query.

SCIENTIFIC ORGANIZATIONS OF KANSAS

Name	*Number of members*	*Possible Number of members*	*Length of meeting, days*
Kansas Academy of Science	430	1,500	3
Kansas Medical Association	1,500	2,000	3
Kansas Engineering Society	241	340	2
State Dental Association	650	900	4
Kansas Veterinary Medical Association	215	415	..
Kansas Geological Society	150	175	Monthly
Kansas Horticultural Society	195	245	2
Kansas Home Economics Society	235	850	2
Kansas Association of Teachers of Mathematics,	125	500	1
Totals	3,741	6,925	

The chemists, psychologists and the sociologists have "regional organizations" which include members from Kansas

From this survey one can see that the scientists of the state are quite thoroughly organized. In addition many of the individual scientists are members of one or several national societies.

The thing that is needed is some means for the various organizations of the state to coöperate and upon certain occasions unite the influence of the scientists so they can act as a unit.

From a study that has been made in the past and as a result of conferences with several leaders of the big national coördinating A. A. A. S., the writer suggests that the academy form a nucleus around which a council can be organized which may meet annually or occasionally and discuss matters scientific for the welfare of the state and also for the welfare of the scientists and their groups. Had there been such an active council an entomologist would not be placed in charge of a disease among horses nor a bacteriologist in charge of an insect survey.

The best plan of organization, according to many, seems to be to have every scientific organization select two of its active workers as its members of a state council. Such a council representing all the scientists might be called the Kansas Association for the Advancement of Science, K. A. A. S. It could meet annually with the Kansas Academy of Science (or sometimes with other groups).

The K. A. A. S. could have as some of its objectives:

I. The spread of science in the state and the increase of its influence.

II. The conservation of natural resources:

- a. By preventing the wastes in the oil, gas, coal and other mineral industries;
- b. By conserving the useful plant and animal life of the state and aiding in the destruction of the harmful ones;
- c. By preventing soil erosion by both water and wind.

III. The improvement of the health of the citizenry:
  a. By improving the water and food supplies;
  b. By pushing the eradication of infectious diseases;
  c. By stopping the ravages of cancer, educating the victims to have early diagnosis and so making possible cures.

Many of you will say that some or all of these objectives are the particular fields of some of our specialized societies. The fact is admitted at once. And yet almost every one of the suggested objectives has interrelationships to several special societies. Take the question of soil erosion by wind. It is, of course, mostly a question for the soil engineer, but the doctors are vitally concerned because the dust is a menace to health; the botanist is needed for the reëstablishment of a plant covering. The zoölogist will need to watch the animals which may aid or destroy the plants or loosen up the soil. And above all the meterologist must help all he can by foretelling the change of seasons.

Similarly almost every other objective of any one particular group will be found to have ramifications with the work of several other societies.

A coördination group could watch these interramifications and might under certain conditions do very useful work. For instance, if antievolution teaching or antivivisection propaganda should be started then the engineers and dentists and doctors could be very much more effective in combating these harmful tendencies than could the teachers or the physiologists. The latter would have personal interests while the former could not be thus accused.

If such a Kansas Association for the Advancement of Science should be organized the writer would suggest as its first activity an attempt to gain its first objective, the spread of scientific influence. The plan might be called Kansas Science Week.

The place and time selected might well be Topeka during the second and third week of the meeting of the legislature. Many or all of the societies might hold meetings partly overlapping as follows: The doctors meeting from Monday to Wednesday; the dentists meeting from Tuesday to Thursday; the horticulturists from Wednesday to Friday, the academy from Thursday to Saturday and other societies on other days or even over into the next week.

Many exhibits could be arranged. Many combined round-table discussions could take place in which members of different groups could discuss problems from their respective angle. Very prominent scientific lecturers could be secured and offered to the public. The legislators could and should be made the guests of these meetings. Some could be asked to discuss state problems at luncheons of various groups especially concerned with the problem under consideration. Very much good could be and would be secured by members of every group.

But best of all such a series of science meetings would be given much publicity. It would call the attention of the people of the whole state to the scientist and his work and stress the importance of science to the state and its citizens.

The author believes that if some twenty active scientific workers would get together they could plan the details of a "Kansas Science Week" that could do great good to themselves, their organizations, the state government and its institutions, and, above all, the people of the state.

If successful such a Kansas Science Week may be repeated about every four years, being held in other large cities.

Drought in Cowley County, Kansas, 1931-1936

WILLIAM LUTHER HOYLE, Kansas State College, Manhattan, Kan.

The writer became interested in the ecological changes in Cowley county, Kansas, brought about by the drought in the past few years, and he desired to study the situation to see if the changes were due to climatic or such mechanical conditions as road grading, removal of trees, destruction of dams, and plowing of the native grasslands.

Cowley county, Kansas, is located in the south edge of the extreme western tier of the eastern third of Kansas counties. It is in an interesting ecological position, as it shows an intergradation between the eastern and western biological forms. Succeeding from east to west across the state of Kansas, the annual amount of precipitation decreases approximately .06 inch per linear mile, and the precipitation increases fairly uniformly from north to south.

During the past five years animal and plant life has been greatly reduced due to ecological changes caused by the severe drought conditions. Many plants, such as sunflowers, and various meadow flowers, started normal growth in the springs and early summers, but due to lack of moisture and severe high temperatures they were not capable of producing normal seeds. It is a question how long these plants are capable of continuing this process, if no seeds are produced over extended periods of time.

The population of animal life which requires water or moist habitats has been greatly reduced. In general, animal extinction occurs at an earlier period than plant destruction, because most animals are incapable of resistance to unfavorable conditions by dormancy. Higher animals must reproduce and keep their progeny in a continuous line, with no stage of dormancy except for short periods of hibernation and aestivation.

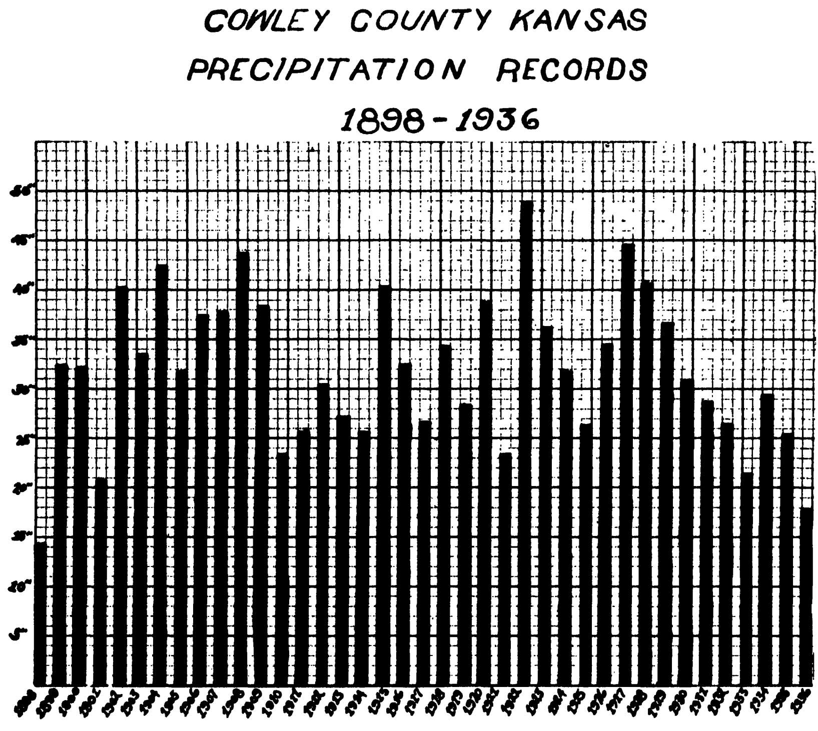
During the past five years the trees, particularly the maple and elm, have decreased by approximately one third, due to the lack of moisture and the prevailing condition to insect attack. When moisture is abundant, trees grow rapidly and are able to resist burrowing insects. When growth is retarded, insects burrow into the outer woody portion and the trees soon succumb to the insect attack. This has been the situation in Cowley county during the prolonged dry period. Newly planted trees were unable to survive during the hot and dry seasons.

In a number of instances the writer has observed that individual repitles, such as collared lizards, *Crotophytus collaris* (Say), *Cnemidophorus sexlineatus sexlineatus* (Linnaeus), the six-lined race-runner, and the common bull snake, *Pituophis sayi sayi* (Schlegel) have been frozen to death, due to inability to dig deeply enough into the hard, dry earth to pass the winter.

In August, 1936, the writer was engaged in fish rescue work in coöperation with the Kansas State Fish and Game Department. Cowley county streams were practically without water except for small pools here and there. The streams had rarely been as low as they were during this time. Many fish and frogs were congregated in small pools of stagnant water. The water in many cases was only five or six inches deep and the dorsal fins of the fish could be seen protruding above the surface. The fish were rescued and taken to

deeper holes and released. Birds during the drought period took advantage of the opportunity and destroyed many game fish. The greatest destruction, however, was from the fouling of the water in drying pools.

Insect pests, especially grasshoppers, became abundant, due to conditions favorable for their existence. Plants were unable to supply sufficient foliage to resist the insect attack. Parasitic fungi on grasshoppers could not develop spores during the hot, dry season, and consequently the grasshoppers remained relatively uncontrolled.



Wild animals and birds suffered from the dry conditions, as they were unable to get sufficient water. Many of them perished while in search of water.

The annual average precipitation[1] of Cowley county, Kansas, for the past thirty-eight years is 30.52 inches per year. However, during the past five years the average annual precipitation has been but 24.02 inches, and at no time during the past five years did it reach the average. (Fig. 1.)

The months in which the most precipitation occurred was an important factor in the drought condition. During the first eight months of 1936 the precipitation was greatly reduced and presents evidence that the decrease was greatly responsible for the extreme drought of 1936. The average precipitation for the months January, February, March and April for the thirty-eight years

1. The precipitation records for Cowley county were secured from Mr. M. B. Light, the United States Weather Bureau Official for Cowley county, Kansas.

was 6.67 inches; for May, June July and August, 14.61 inches; and for September, October, November and December, 9.24 inches. (Fig. 2.) The precipitation during the fall and winter of 1936 exceeded the average for that period, but it was too late to relieve the critical condition under which Cowley county suffered.

Since moisture and temperature are inversely related to one another, Cowley county, during June, July and August, 1936, passed through the hottest and driest period ever recorded for that county. The evaporation was exceedingly great during this period and streams were greatly depleted of water.

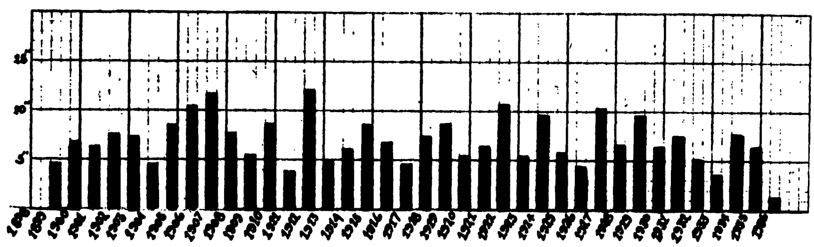
The writer is of the opinion that the straightening of streams, grading of roads, destruction of dams, removal of trees, underbrush and vegetation also plays an important role in the drought situation, as water is rushed off and has no chance to penetrate the soil or remain in pools at the place where it falls.

The Walnut river, near Winfield, Kan., has been straightened and the underbrush removed in order to prevent flood conditions. Cowley county, however, is making an effort to conserve the water by constructing ponds, lakes and terraces. During 1936, thirteen ponds were constructed under the Kansas Emergency Relief Administration, three under the Works Progress Administration, and three others are under construction at the present time. Terracing is increasing rapidly over the county to conserve the water supply and to prevent soil erosion.

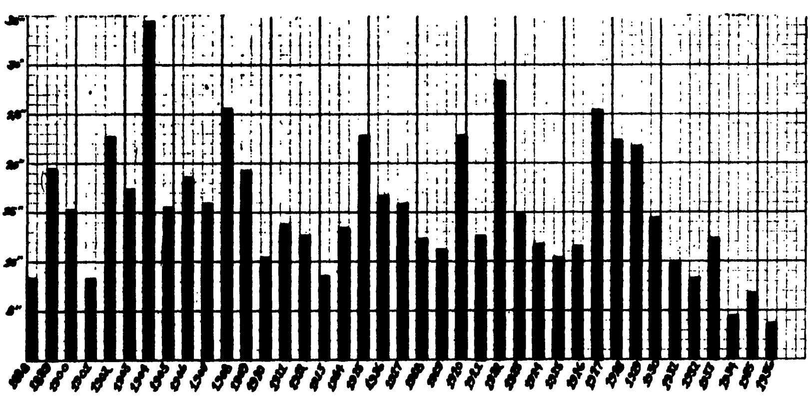
Although the lack of precipitation was primarily responsible for the drought during the past five years, indications show that man is partly responsible for the ecological changes which played a part in augmenting the drought situation in 1936.

COWLEY COUNTY KANSAS PRECIPITATION RECORDS 1898-1936

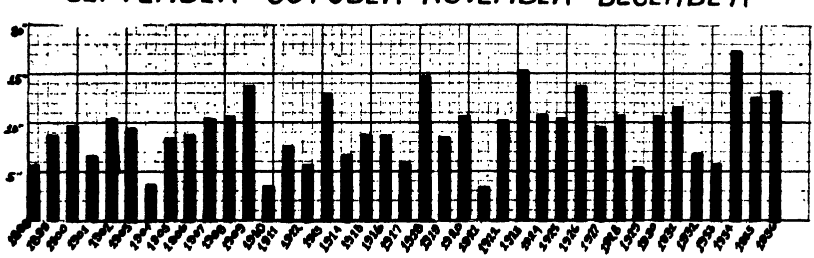
JANUARY-FEBRUARY-MARCH-APRIL



MAY-JUNE-JULY-AUGUST



SEPTEMBER-OCTOBER-NOVEMBER-DECEMBER



Some of the Founders and Workers of the Kansas Natural History Society and the Kansas Academy of Science

LYMAN C. WOOSTER, Emporia, Kan.

In the middle 1860's with the establishment of the state government at Topeka and the organization of the State University at Lawrence, the State Agricultural College at Manhattan and the State Normal School at Emporia, many young men and women, fresh from college, came to Kansas to take positions in these several institutions.

Kansas at that time was new ground for workers in the sciences and they speedily began investigating their novel surroundings, finding much that was new to these teachers educated in the eastern colleges. Those interested in natural history speedily gravitated to a common center and founded the Kansas Natural History Society in 1868. The members subdivided the field for investigation, each taking subjects for study in which he had become especially interested in his college days "back east."

The first president of the Natural History Society, Prof. B. F. Mudge, of the Agricultural College, selected for his special line of work, geology, and traveled widely over the state collecting rocks, fossils and minerals and making frequent reports to the Society, describing his discoveries. His trips over western Kansas were made somewhat dangerous by the hostility of the Indians, who did not understand why he should be collecting rocks from their hills, and other hunters should be killing their buffalo with many-shot guns.

A president of the Agricultural College who was not acquainted with Mudge was not wiser than these natives of Kansas, for he caused his collection of "old bones and stones" to be thrown out of the museum onto a refuse heap. Some weeks later Professor Mudge visited Manhattan and investigated the refuse heap. He discovered some fossil shells new to science that he had collected in Saline county.

Very fortunately the bones of toothed birds, Odontornithes, which Professor Mudge found in western Kansas were not left in the museum of the Agricultural College, but rest securely in the museum of Yale University.

Among these collectors of specimens in natural history, Prof. F. H. Snow of the State University, ranks easily first. In 1905 he had in his collection of insects more than 170,000 specimens belonging to 21,000 species. Besides this magnificent collection of insects, Doctor Snow had made a fine collection of plants, several Kansas meteorites, a complete list of Kansas birds, a good collection of fossils and had accumulated valuable data for a study of Kansas weather.

Doctor Snow learned that the museums of the world were anxious to get specimens of a certain tiger beetle that might be found in semiarid regions such as those in western Kansas. He accordingly made a trip to western Kansas with some student helpers. At first unsuccessful, the party found this beetle, *Amblychila cylindriformis,* in great abundance, so many that Doctor Snow sold part of the collection for enough to pay the expenses of the trip and the expenses of the students until they graduated.

Warren Knaus, editor of a paper at McPherson, Kan., collected only beetles, but with such success that in 1905 he had collected members of 5,512 species and in 1931 had increased the number to about 75,000 specimens belonging to

10,000 species, of which 25 were new to science. He keeps his collection in a burglar-proof safe and fire-proof vault.

The chemists have always been prominent members of the Natural History Society and Academy. They were easily followed when they read papers pertaining to subjects in inorganic chemistry; but when they gave long discussions of formulae belonging to organic chemistry, many of the members wished that they would read their papers elsewhere. The *results* of experiments in organic chemistry alone could be understood.

Dr. J. T. Willard of the Agricultural College, later State College, gave many discussions of matters of special interest to farmers respecting farm crops and farm animals, and directed the work of many other members of the college faculty in their study of subjects vital to the success of farm life.

Professors E. H. S. Bailey and L. E. Sayre of the State University gave most of their time to the discussion of subjects of interest to the housekeepers and to the sanitary condition of the cities of the state. When both were alive they always came together to the meetings of the Academy and seemed like twins in planning the reports of their work.

In volume 1 of the Transactions of the Academy, the first list of plants was published, prepared by the Reverend and Professor James H. Carruth, a pioneer Kansan who had settled on a farm near Osawatomie, but after a few years was elected to a professorship at Baker University where he remained three years and then moved to Lawrence, preaching in a nearby city. Reverend Carruth gave much of his time to the study of plants and later lectured on botany at Washburn College. In the centennial year he published a more complete list of plants, aided by Doctor Snow and others. This list is given in volume 5 of the Transactions.

Professor and Mrs. Kellerman prepared valuable keys for the identification of forest trees, volume 10, and Professor Kellerman published at about this time studies on parasitic fungi. He had, at Manhattan, issued a pamphlet on the grasses of Kansas. Professor Hitchcock, also of Manhattan, printed in volume 14 of the Transactions a further study of the grasses.

The study of plants seems to have been very attractive to members of the Academy, and many lists of plants for counties were given. Studies of special types were made by Prof. W. C. Stevens of the State University and Frank U. G. Agrelius of the State Normal School and Teachers College of Emporia.

Elam Bartholomew, a farmer of Rooks county, became a world authority on fungi from his home studies of this important group of plants, and B. B. Smyth, long a curator of the Goss collection of birds at Topeka, with his second wife, Mrs. Lumina C. Riddle Smyth, started an exhaustive catalogue of the flora of Kansas in volumes 23, 24 and 25 of the Transactions. Mr. Smyth, in his long membership, printed numerous accounts of his multiform experiences in many lines of reasearch.

The birds of Kansas received the early attention of the naturalists. Prof. F. H. Snow contributed the first list of birds to the Society and it was printed in volume 1. Professor Snow made numerous additions to the list in succeeding volumes until the list reached nearly 400. He was very careful not to include any names until he had verified reports of additional birds that came to him. One time he made a trip of about 300 miles to make sure that a bird, the road runner, if I remember correctly, was in Kansas of his own free will.

N. S. Goss soon began his study of birds and made numerous reports of his finds to the Academy. In 1886 he published a catalogue of Kansas birds. This list, as revised, embraced 335 species and races. Of these 175 were known to breed in the state. In 1891 he published a volume of 692 pages on Kansas birds. It is said that when the first copy of this great work reached him from G. W. Crane and Company, the Topeka publishers, he was greatly pleased; but died soon afterward. His fine collection of mounted bird skins is preserved in the Memorial Building, Topeka.

Prof. M. V. B. Knox of Baker University listed the mammals of Kansas in volumes 4 and 5. D. E. Lantz of Manhattan, later of the U. S. Department of Agriculture, Washington, D. C., published a revised list of mammals in volumes 19 and 20, part 2. A. B. Baker, of Wakeeney, listed the mammals of western Kansas in volume 11. Lewis L. Dyche, of the State University, prepared a much longer catalogue of mammals, according to Professor Lantz, but it has never been published in the reports of the Academy. Professor Dyche prepared a fine collection of mounted skins of mammals for the University Museum, probably the largest collection of mammals in the west. Professor Dyche visited the Artic regions for rare specimens, and made plans for visiting the North Pole.

Robert Hay, a worthy successor to Prof. B. F. Mudge in studying the geology of Kansas, settled on a farm in Geary county, taught in high schools and institutes for a few years, but became interested in the geology of his adopted state and served under the State Board of Agriculture in investigating various phases of geology of special interest to farmers. He finally entered the service of the United States Geological Survey in reporting on the underground waters of Kansas.

He contributed many papers to the Transactions. His last paper was a very full bibliography of Kansas geology, printed in volume 14.

Following Robert Hay came a long list of those who were interested in studying some phase of Kansas geology. Geo. I. Adams made an examination of the Neosho river valley and prepared a physiographic map of Kansas. J. W. Beede made a careful exploration of Shawnee county, studying its geological strata. C. N. Gould, after hearing a lecture on geology by L. C. Wooster at a Kingman county institute, decided to study geology. After much preliminary study, he prepared a paper on the Dakota Cretaceous of Kansas and Nebraska. This was printed in volume 17 in 1900 as a paper of over fifty pages. Professor Gould became state geologist of Oklahoma. Alva J. Smith, working with a local geologist, printed in the Transactions several papers on the geology of Lyon county. Erasmus Haworth received the chair of geology at Kansas University. This carried with it the position of State Geologist. The discovery of natural gas and oil in eastern Kansas, and then west and still farther west, made the state legislature willing to grant to a State Geological Survey all the funds it needed for the geological investigation of the entire state.

As a result of this liberality the entire state was studied by various parties led by George I. Adams, John Bennett, M. Z. Kirk, John G. Hall, E. B. Knerr, Charles S. Prosser, F. W. Cragin, W. N. Logan, S. W. Williston, J. W. Beede and Erasmus Haworth, with special studies by several others.

The results of these surveys were embodied in reports published in nine large volumes and nearly as many bulletins. Later this work was continued by Raymond C. Moore, assisted by J. E. Todd, Walter H. Schoewe and other

specialists. The cream of much of this geological survey study of Kansas found its way into the Transactions of the Academy.

Dr. S. W. Williston, after publishing a fine volume on the diptera, took up the study of the fossil vertebrates of Kansas and made a national reputation in this field. C. H. Sternberg and a son, George F., have made extensive collections of the fossil vertebrates of the great plains, greatly enriching our knowledge of this important group. Many lists of fossils have been prepared by them.

The study of living plants and animals receives most of the attention of the present members of the Academy, especially the habits and needs of those still struggling for a larger place on mother earth.

I. D. Graham prepared a list of Kansas fish for volume 9. F. W. Cragin gave a list of reptiles and batrachians in volume 7, and of the copepods in volume 8. Miss Annie E. Mozley listed the snakes in the museum of the State University in voume 6. Edwin A. Popenoe, of Manhattan, listed the Unionidae in volume 9.

The lists of plants and animals, interesting to the ones who make them, are of little value to the student and to the amateur in natural history unless they are accompanied by keys or pictures or both. The specialist alone finds the lists valuable, as they assist him in getting the distribution of the species in which he is interested.

Biology embraces so many subtitles requiring study and report that many members of the Academy find here numerous subjects for papers. These papers may cover statements of methods of investigation, and a brief statement of the results. The second part is always interesting to members of the Academy, but the first part is chiefly valuable to the one who reads the paper.

Darwin's chief contribution to science rests on his painstaking studies of variation, heredity and struggle for existence and survival of the fittest. The last is now named ecology, and many members of the Academy find here many subjects for interesting studies.

The members from the State College at Manhattan have usually taken some subject valuable to farmers as well as to science in general. These papers have been very numerous and only a few can be mentioned here. Robert K. Nabours has specialized on the study of certain species of grasshoppers; James E. Ackert has made frequent reports on parasitology; George E. Johnson was secretary of the Academy for several years and as mammalologist for the Kansas Agricultural Experiment Station reported on various pests among the small mammals; F. C. Gates has prepared excellent volumes on the forest trees the poisonous plants, the wild flowers of Kansas and the grasses of Kansas—the latter two illustrated by Mrs. Albert Dickens. Except the poisonous plants these volumes have been published by the State Board of Agriculture. Roger C. Smith is the secretary of the Academy and has presented studies of insects; Mary T. Harman has given studies of embryology; and Theodore H. Scheffer has given valuable papers on Kansas spiders, volumes 19 and 20, part 1.

The Kansas State University, as a university, has a school for each greater department of human learning. The members of its faculty, beginning with Snow, Bailey, Sayre and Williston, have always taken leading parts in the proceedings of the Academy. Of the later workers, H. P. Cady, F. B. Dains, Robert Taft and F. W. Bushong have reveled in the mysteries of chemistry

and physics; E. Miller has shown his love for astronomy, and Vernon Kellogg, F. H. Sellards, W. J. Baumgartner and E. S. Tucker have continued the studies of animals begun with success by the older members of the Academy. F. O. Marvin, as dean of engineering for that school of the university, read many papers on subjects especially interesting to engineers.

At the State Normal School and Teachers College of Emporia, Prof. D. S. Kelley was chiefly interested in building a great museum for the school. L. C. Wooster, for thirty years the head of the department of biology and geology, has made merely a private collection of fossils, but has read many papers at the Academy on the results of scientific investigations. Frank U. G. Agrelius has given numerous reports on the progress in botanical knowledge.

J. A. Yates of the Pittsburg Teachers College presented several papers on descriptive geology. The Fort Hays State College, being located towards the western end of the state, has given the members of its faculty, who were also members of the Academy, a slant towards the discussion of semiarid conditions. Roy Rankin emphasized the value of a knowledge of chemistry and Arthur W. Barton discussed phases of botany. L. D. Wooster developed in several papers and in his presidential address the importance of a study of the economic relations existing among plants and animals, their ecology, a subject of growing importance in scientific investigations, displacing much of the formalistic studies of the basic classifications of these organisms.

W. A. Harshbarger, of Washburn College, gave some very interesting facts in his presidential address in volume 27. He records that the newly elected president of Lincoln College (Washburn), feeling the need of a Natural History Society such as he had enjoyed in Illinois, joined with others in issuing a call for a meeting of those interested in scientific work at Lincoln College (Washburn), Topeka, the fall of 1867. Those who met to organize such a society were few in numbers but rich in the desire for better scientific work. Those who met were John Fraser, D. H. Robinson, B. F. Mudge, J. A. Banfield, J. S. Hougham, Pres. J. D. Parker, R. A. Barker, D. Brockway, G. E. Chapin, J. H. Carruth, R. D. Parker, Jeff. Robinson, Peter McVicker, F. H. Snow, J. S. Whitman, Richard Cordley and J. R. Swallow. B. F. Mudge was chosen president.

F. W. Cragin of the Natural History Department at Washburn did excellent work on the older Cretaceous of western Kansas. J. T. Lovewell presented papers in physics and chemistry and was secretary of the Academy for several years.

H. H. Nininger, of McPherson College, was interested in general natural history problems until he took for his special work the study of meteorites. H. J. Harnley developed his specialty, biology; and J. W. Hershey has given several papers on the effects of several different gases on the lower mammals.

Miss Hazel E. Branch, of the University of Wichita, has done fine work in organizing and developing a Junior Academy, which meets at the same time and place with the senior organization.

L. D. Havenhill, of the University of Kansas, has given many papers of interest to pharmacists of Kansas. H. B. Hungerford, of the University, has kept up the study of insects, adding to the great work of Doctor Shaw.

In an early day the study of natural history in the United States was given a safe foundation by the coming to this country of many men who had achieved eminence in this field of study in central Europe. Audubon classified our birds and described their habits; Lesquereau identified 460 forest trees

from their leaves found in the rocks of central Kansas; Agassiz founded the study of glacial geology and the teaching of biology; Guyot published an excellent text on physical geography, and several others came who were skilled in the science of war.

In Kansas, F. F. Crevecour, of Onaga, made a wonderful collection of insects and published his lists in the Transactions of the Academy. In this general field he rivaled Warren Knaus in his special field.

Alva J. Smith, in his capacity of county engineer, gained a knowledge of the rock strata of Lyon and eastern Chase counties. Assisted somewhat by a local geologist he published from time to time the results of his observations in the Academy Transactions.

A. M. Thompson, a dentist of Topeka, became very much interested in the work of the Society and Academy and read several papers on science in general. In volume 9, he gave a brief history of the Society and its transition into the Academy.

E. B. Knerr, of Highland College, while in Kansas, used his knowledge of chemistry in the preparation of several papers for the Academy. He evidently enjoyed the results coming from scientific studies.

Dr. J. M. McWharf devoted his papers to the discussion of what conduces to the physical welfare of people. J. R. Mead, one of the nearly settlers of Kansas, gave many papers devoted to the geography of our state and its early history. Charles H. Sternberg, with a son, George F. Sternberg, is one of our most persistent collectors and observers of its natural history.

L. E. Melchers, of the State College at Manhattan, has given interesting descriptions of plant diseases. A. B. Reagan, at work with the Indians, has presented many papers on the natural history of the western part of the United States. R. H. Zinszer, of the Fort Hays State College, the Academy treasurer, has treated phases of mathematical physics.

An excellent example of a valuable list with a key is published in volume 38, A Key to the Lizards of the United States and Canada, by Charles E. Burt, beginning on page 255. At the recent meeting at Lawrence, Rev. John T. Copley, a life member, read a paper describing the forces in a tornado.

The writer, at least, has found these reminiscences very interesting, and he will conclude with one or two suggestions. Several hundred papers have been read by members of the Academy of which no record has been made other than their titles. All of these have established one or more facts in natural history or in science. It should be possible to gather these facts of observation into hypotheses and later into conclusions of great value in science. Alone these facts are like the wind that blows or the rain that falls, of high value for the moment, but leaving no trace of their having existed.

The writer of every paper that is not printed should leave a statement of its conclusions with the secretary to be filed away for future reference. A paper was read at the recent meeting at Lawrence by Charles R. Gilbert, on New Species of Earthworms for Kansas. So far as the writer knows nothing remains of this paper except memories in the minds of the hearers.

The table of contents printed in volume 33 of the Transactions of the Academy have been exceedingly helpful to those who wish to know what the members of the Society and Academy have done in the study of the natural history of Kansas or in the formulation of conclusions in science valuable to its inhabitants. These should be continued in succeeding volumes from time to time.

A Preliminary Report on a New Mammal-like Reptile from the Permian of South Africa

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INTRODUCTION

In 1929 Dr. Alfred S. Romer and Mr. Paul C. Miller returned to Walker Museum of the University of Chicago with a number of fossil vertebrates from the Karroo system in South Africa. The specimen to be described was one of that number and had been collected by them from near the top of the *Tapinocephalus*-zone along Hottentot's river in the District of Beaufort West.

The specimen, identified as a rather large herbivorous dinocephalian, consists of an almost complete vertebral column, a great number of rib fragments, and the principal portions of the girdles, limbs and feet, both pectoral and pelvic. The skull is missing and only a portion of the lower jaw is preserved. It is proposed to describe the dinocephalian very briefly, to compare it with other dinocephalians, and to summarize that group's relations to other groups of mammal-like reptiles by means of a short discussion of therapsid phylogeny.

DESCRIPTION OF *MOSCHOIDES ROMERI*, gen. et sp. nov.

Moschoides romeri is an herbivorous dinocephalian closely similar, structurally, to *Moschops capensis*. Moschoides may be distinguished from Moschops by the following characters: (1) Its somewhat greater size; (2) the greater massiveness of the first sacral rib as compared with the second; (3) the relatively longer anterior process of the ilium, and (4) the more vertically-placed femora.

The name *Moschoides romeri* is proposed for the specimen at this time. The generic name serves to indicate its similarity to the related genus Moschops, and the specific name to acknowledge indebtedness to Doctor Romer for referring the specimen to me and for his aid in its description. The postcranial structures of Moschoides assign it to the dinocephalians. That it is a member of the herbivorous group is indicated clearly by the teeth still preserved in the jaw fragments. The most anterior teeth are of a quadrangular-ovate cross-section, the longer axis being normal to the curve of the jaw (figs. 6, 7). Posteriorly the teeth not only decrease in size, but tend also toward a more circular cross section. This same dental structure is displayed in a much better state of preservation in Moschognathus.

The major portion of the vertebral column (figs. 1-5) is fairly well preserved. There seem to have been seven cervical vertebrae, a break appears in this section thus making the exact number uncertain, seventeen thoracic vertebrae, five lumbar vertebrae, three sacrals, and at least fourteen caudals.

The centra are distinctly amphicoelous with this character at its maximum in the lumbar region. The centra are dorsoventrally elongate, bear rather prominent ventral keels, and are notched dorsally for the passage of the neural cord. Intercentra are not present posterior to the axis-atlas.

The neural arches are suturally united to the centra and rise to short, but stout, neural spines. The anterior zygapophyses are long and slender, the posterior, appreciably shorter. Laterally there are stout, down-curving trans-

verse processes. Facets for the capitula of the ribs are situated intercentrally. The neural spine of the axis is much more powerfully developed than that of any other vertebra, being much higher and longer.

Four coccygeal vertebrae are indicated. The true caudals bear well-developed haemal arches. At the very end of the column the caudals are reduced to mere checker-like centra.

The ribs (figs. 8-10) show evidence of regional specialization. Apparently present on all presacral vertebrae, they lengthen and become more massive posteriorly in the cervical region and attain a maximum in length and massiveness in the thoracic region, after which they decrease uniformly toward the sacrum. While plainly dichocephalus anteriorly, the ribs become less so in the lumbar region where they approach a holocephalous condition.

The first sacral rib (fig. 12) is unusually massive and is essentially holocephalous. Laterally it expands greatly for its contact with the ilium. The second and third sacral ribs are much less massive. In the coccygeal and caudal regions the ribs, laterally-directed bars, become successively shorter, they being represented only as nubbins of bone in the most posterior vertebrae.

The shoulder girdle is fairly complete. The scapula (fig. 22) is a massive bone, thickened greatly along its posterior edge. It forms the upper half of the glenoid cavity. The upper portion of the scapula is missing and consequently there is no indication of a cleithrum, though one probably was present.

The coracoid (fig. 21), which forms the remainder of the glenoid, is a rather small element, but bears a well-developed coracoid process. The precoracoid (figs. 23, 25) is much larger, considerably thinner, and is moderately convex. It is thickened only in the glenoidal corner where, also, it is pierced by a large supra-coracoid foramen.

The clavicles (fig. 25) are moderately expanded elements somewhat constricted in their middle portions. The interclavicle (fig. 24) is not complete.

The humerus (figs. 26, 27) is a powerfully developed element. There is a strong delto-pectoral crest, a somewhat constricted shaft, and two moderately developed distal condyles. Apparently there is only an entepicondylar foramen.

Both radius and ulna (figs. 28, 29) are conspicuously flattened anteroposteriorly. The ulna, the longer bone, carries a strong olecranon process.

The carpus (fig. 30) consists of three rather large proximal elements, two central elements, and five rather small distal carpals. The metacarpals are unusually small with the exception of the fifth which is expanded and platelike. The phalangeal formula is 2-3-3-3-3, the first phalanx in each digit being unusually short.

The pelvic girdle is characterized particularly by the long anterior process of the ilium (figs. 11, 12). The acetabulum is roughly circular in outline. The pubis (fig. 13) and ischium (fig. 14) are badly weathered along their contacts. Apparently, however, they were much like those of Moschops in size and proportions.

The femur (figs. 15, 16) is a long element and is considerably flattened anteroposteriorly. It bears a well-defined head and two sharply demarked distal condyles. The lesser trochanter is not evident but the great trochanter is well-developed.

The tibia (figs. 18, 19) is very short. While greatly constricted along its

shaft, it flares broadly at either end. The fibula (fig. 17), although not complete, appears to be a more slender element.

The tarsus (fig. 20) is represented by a massive astragalus, an expanded platelike calcaneum, a rather small navicular, and four distal tarsals, the first three of which are quite small. It would seem that a good deal of cartilage must have been present in life to complete the ankle structure.

The metatarsals and the digits are similar in size and shape to the corresponding elements in the forefoot. The distal portion of the hindfoot is much weaker, however, in comparison with the forefoot.

Reconstructed (fig. 31), *Moschoides romeri* seems to have been a large, powerful herbivore, one of the largest animals of Middle Permian times. The high shoulder region was supported by the powerful forelimbs, the elbows of which were directed markedly outwards. The vertebral column sloped down towards the pelvis which was supported by the vertical hindlimbs. The tail was fairly short.

It would seem, from the character of the dentition and of the forefeet, that the diet of Moschoides might have consisted of the low-growing plants found along seacoasts or watercourses. These plants probably were torn loose, or their softer roots dug up, by the powerful forefeet and then crushed by the strong anterior teeth. The exceedingly weak structure of the hindfeet suggests a marshy habitat.

COMPARISON WITH OTHER DINOCEPHALIANS

Comparisons with other dinocephalians, herbivorous and carnivorous, and with the other therapsid groups as well, have been based exclusively on postcranial structures. Among the herbivorous dinocephalians, Moschoides is probably to be referred to Gregory's "subfamily Moschopinae." Postcranial differences in the group relate mainly to size, Moschoides being intermediate between Moschops and the very large Keratocephalus. Two evolutionary series are suggested for the subfamily, one leading from Moschops to Keratocephalus and the other, from Moschognathus to Moschoides. The Tapinocephalus line, Gregory's "subfamily Tapinocephalinae," seems to represent an even more primitive branch than the Moschopinae.

Structures in the herbivorous dinocephalians are readily derived from those of the carnivorous dinocephalians. What differences there are, appear to be adaptive only. Generally, the carvivorous forms seem to have been somewhat longer, more slender, and with their front limbs more powerful in the proximal portions.

THERAPSID PHYLOGENY

The mammal-like reptiles represent an evolutionary line (fig. 32) presumed to have developed from the very primitive reptiles, the cotylosaurs, not improbably from some early, unknown captorhinomorph. The first evolutionary stage, perhaps, is represented by the pelycosaurs from which the higher mammal-like reptiles, the therapsids, might later have been evolved.

The anningiamorphs seem intermediate between the cotylosaurs and the more advanced therapsids. The gorgonopsians appear to lie next in the series, perhaps giving rise on one hand to the phylogenetically sterile cynodonts, and on the other, to the more progressive dromasaurs. The dromasaurs, in turn, might have given rise to two closely related sterile lines, the dicynodonts and

the dinocephalians, and to a still more progressive group, the therocephalians. From that group, possibly, came the bauriamorphs, and from them, the ictidosaurs. Of all therapsid groups, the ictidosaurs appear to be closest to the mammals.

On the basis of postcranial structures, the therapsids lie nicely between the pelycosaurs and the mammals. Phylogenetically, they evidence the progressive stages in the evolution of a primitive mammal from a primitive, but typical, reptile.

PLATE I

FIG. 1. Atlas-axis complex, lateral aspect.
FIG. 2. Seventeenth vertebra, lateral aspect.
FIG. 3. Twenty-fourth vertebra, lateral aspect.
FIG. 4. Caudal vertebrae, lateral aspect.
FIG. 5. Caudal vertebrae, ventral aspect.
Fig. 6. Right ramus of lower jaw, lateral aspect.
FIG. 7. Right ramus of lower jaw, superior aspect.
FIG. 8. Dorsal rib, left side, posterior aspect.
Fig. 9. Dorsal rib, left side, anterior aspect.
FIG. 10. Twenty-fourth rib, left side, anterior aspect.
FIG. 11. Left ilium, external aspect.
FIG. 12. Sacrum and left ilium, superior aspect.
FIG. 13. Left pubis (?), superior aspect.
FIG. 14. Right ischium, ventral aspect.
FIG. 15. Right femur, posterior aspect.
FIG. 16. Right femur, anterior aspect.
FIG. 17. Right fibula, internal aspect (?).
FIG. 18. Right tibia, external aspect.
FIG. 19. Right tibia, posterior aspect.
FIG. 20. Left pes, dorsal aspect.

PLATE I

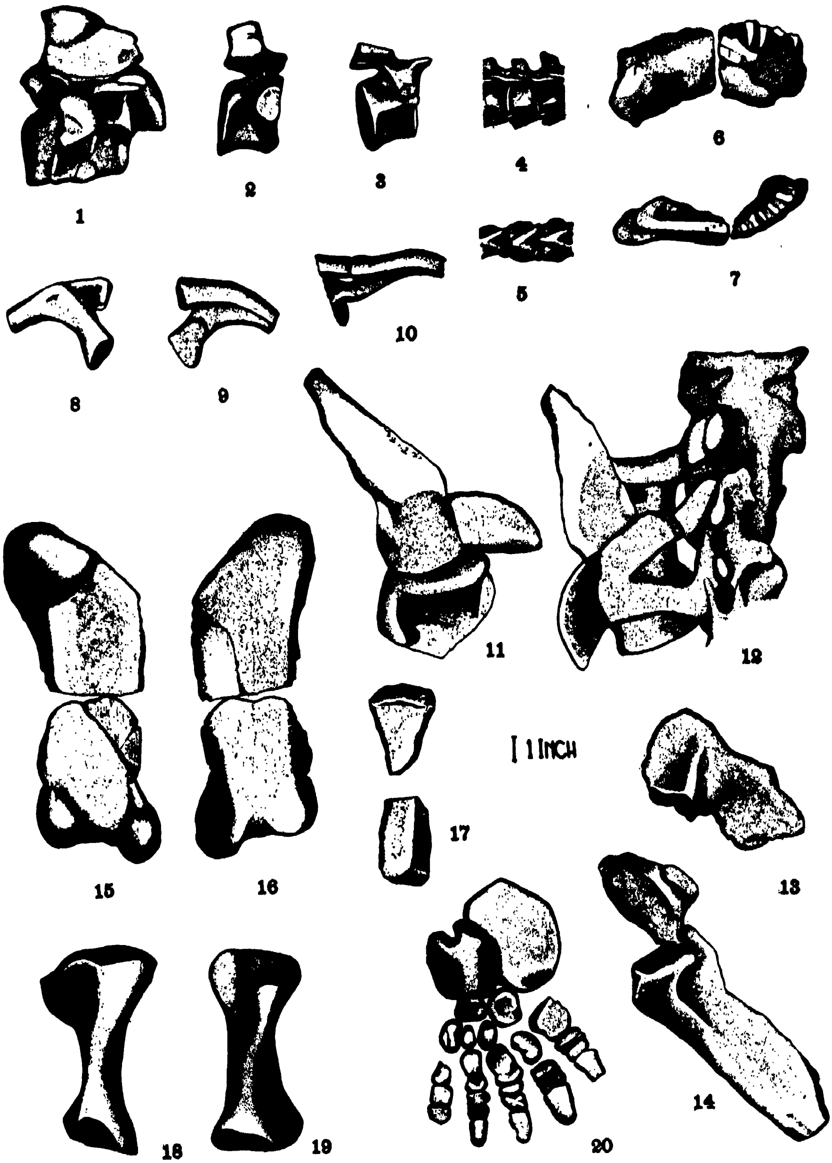
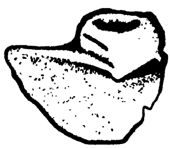


PLATE II

FIG. 21. Left coracoid, internal aspect.
FIG. 22. Left scapula, external and posterior aspects.
FIG. 23. Left anterior coracoid, external aspect.
FIG. 24. Interclavicle.
FIG. 25. Right clavicle and anterior coracoid, external aspect.
FIG. 26. Left humerus, external aspect.
FIG. 27. Left humerus, internal aspect.
FIG. 28. Left radius and ulna, posterior aspect.
FIG. 29. Left radius and ulna, anterior aspect.
FIG. 30. Left manus, ventral aspect.

PLATE II



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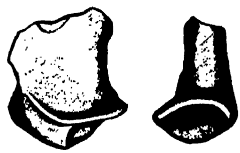

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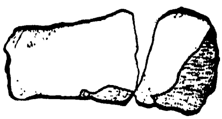

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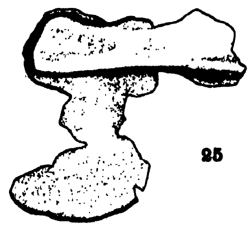

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27

28

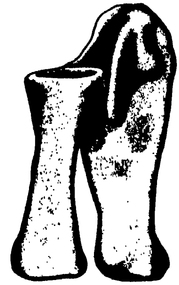

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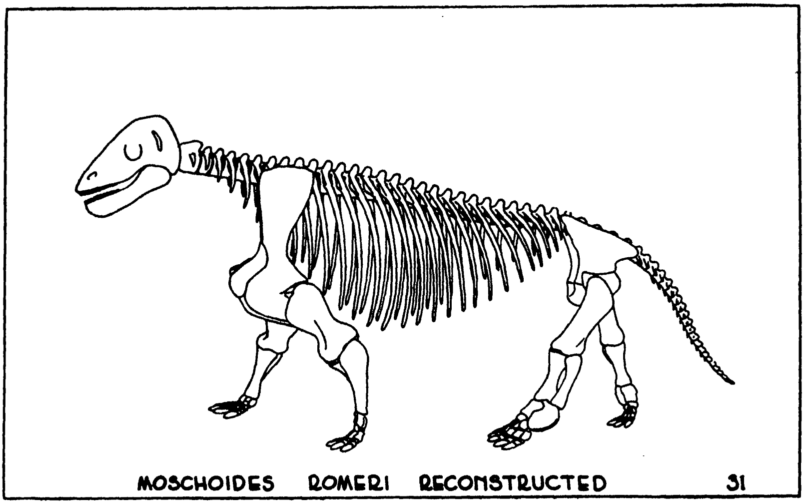
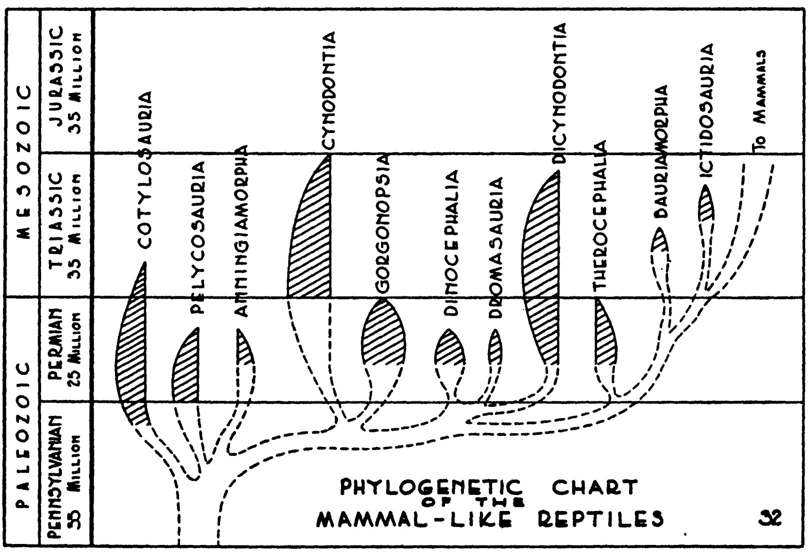
PLATE III

Fig. 31. *Moschoides romeri* reconstructed.
Fig. 32. Phylogenetic chart of the mammal-like reptiles.

PLATE III


MOSCHOIDES ROMERI RECONSTRUCTED
31


PALEOZOIC
MESOZOIC
PENNSYLVANIAN 35 MILLION
PERMIAN 25 MILLION
TRIASSIC 35 MILLION
JURASSIC 35 MILLION
COTYLOSAURIA
PELYCOSAURIA
ANNINGIAMORPHA
CYNODONTIA
GORGONOPSIA
DINOCEPHALIA
DROMASAURIA
DICYNODONTIA
THEROCEPHALIA
DAURIAMORPHA
ICTIDOSAURIA
TO MAMMALS
PHYLOGENETIC CHART OF THE MAMMAL-LIKE REPTILES
32

Notes on Some Vertebrates from the Pleistocene of Kansas[1]

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ABSTRACT: The occurrence of *Mephitis mesomelas varians* (Gray); *Citellus elegans* (Kennicott); *Geomys lutescens* (Merriam); and *Camelops* cf. *kansanus* Leidy in the Pleistocene of Kansas.

In the past fifty years a large number of vertebrates have been taken at random from the Pleistocene of Kansas. Most of these are bones of elephants and mastodons; their size making them attractive. The beds yielding these bones have never been studied, and no effort has been made to correlate their age with that of other faunas from regions where the Pleistocene has been carefully worked. A study of the vertebrate fauna of the Pleistocene of Kansas still remains a virgin field for students of paleontology. The known deposits should be carefully worked and especial attention given to the search for small rodents. The small rodents will probably be the main key upon which the correlation of the beds may be determined. Most of the deposits contain rodent material, but they have been overlooked, due to their small size.

During the past summer a few new forms have been added to the Pleistocene vertebrate fauna of Kansas. These are placed on record to show their distribution during the phases of the ice age.

Mephitis mesomelas varians (Gray) (Fig. 1)

In the collection of vertebrates made during the summer of 1936 by Dr. H. T. U. Smith of the Department of Geology and the Kansas Geological Survey, is a part of a right lower jaw No. 3940 K.U.M.V.P. containing M_1, referable to *Mephitis mesomelas varians*. The specimen was compared with a large number of jaws of that species of skunk taken from Barton county and the surrounding region. No difference could be found to separate it from the living subspecies. It was sent to Dr. E. Raymond Hall who examined the specimen and considered it as that of the subspecies now existing in that area.

The specimen was taken by Doctor Smith in Barton county, one mile south and two and one half miles west of Claflin, Kan., where it had been uncovered by the wind in an ancient sand dune. It was associated with invertebrate fossils of the same age.

Citellus elegans (Kennicott) (Fig. 2)

A left lower jaw, No. 3958 K.U.M.V.P., collected by Mrs. H. T. U. Smith, along an old terrace of the Arkansas river one mile east and three-quarters mile north of Garden City, Finney county, Kansas, belongs to this species. This is the first record of *Citellus elegans* from the Pleistocene of Kansas, thereby extending its range during the ice age considerably southward. The type of preservation and lack of wear by stream transportation indicates that the jaw was not washed into the region from the west. *Citellus elegans* was very abundant in Nebraska during certain phases of the ice age, especially where it occurs from the late Sangamon throughout the Iowan age (Neb. Geol.

1. The study involving the description of this fauna has been forwarded by a grant from the University of Kansas Research Fund.

Surv. Bull. 10, 1935). At present the deposit cannot be correlated definitely with any in Nebraska. A number of Pleistocene invertebrates were found associated with the jaw.

Geomys lutescens (Merriam) (Fig. 3)

While working in Meade county, Kansas, in the summer of 1936 a Pleistocene deposit was visited southwest of Meade, Kan., on the Big Springs ranch. At the time the deposit was visited a search was being made for Upper Pliocene deposits and only the few fossils exposed were collected. A skull, No. 3959 K.U.M.V.P., taken about four feet from the top of the exposure, proved to be that of *Geomys lutescens*. While in Meade county a series of recent mammals was collected, the only gophers observed were found along the lowlands and small streams. Those taken were *Geomys b. llanensis*. *Geomys b. llanensis* is known to occur throughout the Arkansas river valley to the Colorado line. How far up the river into Colorado the form extends is unknown. The present known distribution of *Geomys lutescens* in Kansas is in the northwest fourth of the state. Just where its range meets that of *G. b. llanensis* is not known. The phase of the Pleistocene from which the skull was taken is not known, but a fine exposure exists in which are many Pleistocene invertebrates.

Camelops cf. *kansanus* Leidy (Fig. 4)

Associated with the skull of *Geomys lutescens* is a left M_2, No. 3960 K.U. M.V.P., of a camel referable to the above form.

Anteroposterior diameter of crown, 45 mm.; greatest transverse diameter of crown, 23 mm.; height of crown, 52 mm.

PLATE I

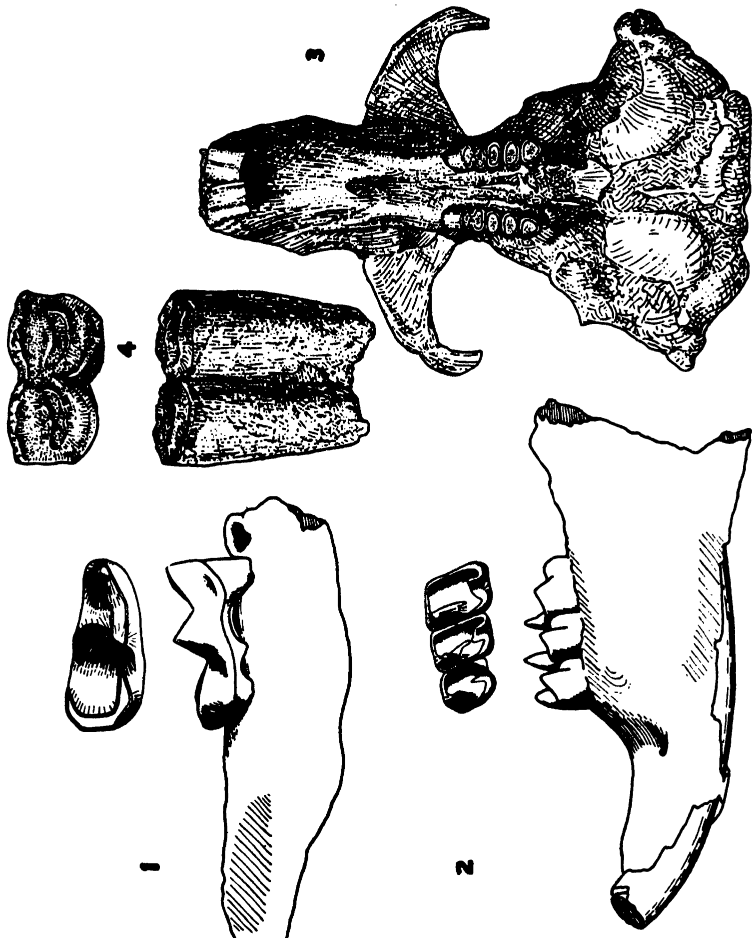
FIG. 1. *Mephitis mesomelas varians* (Gray), labial view of right lower jaw with M_1 and crown view of K.U.M.V.P., No. 3946, $\times$ 2.

FIG. 2. *Citellus elegans* (Kennicott), labial view of left lower jaw with P_4, M_2, and crown view of K.U.M.V.P., No. 3958, $\times$ 3.

FIG. 3. *Geomys lutescens* (Merriam), ventral view of skull of K.U.M.V.P., No. 3959, $\times$ 1½.

FIG. 4. *Camelops* cf. *kansanus* Leidy, labial and crown view of left M_2 of K.U.M.V.P., No. 3960, $\times$ ½.

PLATE I



An Upper Pliocene Fauna from Meade County, Kansas[1]

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ABSTRACT: A large vertebrate fauna from the Upper Pliocene of Kansas showing evidence of members of a boreal fauna associated with that of a more southern fauna. Indicating the climatic change which appeared in advance of the Pleistocene glaciation. Five classes of vertebrates are represented in the fauna. The paper treats only the Mammalia, which is represented by 7 orders, 14 families, 23 genera and 10 species of which the following are described as new: *Sorex taylori* sp. nov.; *Eocastoroides lanei* gen. et sp. nov.; *Peromyscus eliasi* sp. nov.; *Sigmodon intermedius* sp. nov.; *Pliolemmus antiquus* gen. et sp. nov.; *Pliophenacomys* subgen. nov.; *Phenacomys primaevus* sp. nov.; *Kansasomys meadensis* gen. et sp. nov.; *Neondatra kansasensis* gen. et sp. nov. With text figures.

INTRODUCTION

In the spring of 1936 Dr. M. K. Elias, of the Kansas State Geological Survey, brought to the Kansas University Museum a number of horse teeth, two Proboscidean teeth, a Canis jaw and a "Saber toothed" cat tooth which he had recovered while in Meade county. At the time of his visit to Meade county, a number of CCC workers were digging into the deposit and taking the teeth for souvenirs.

A field party went to Meade county to collect from the deposit in the summer of 1936. Upon our arrival it was found that the entire deposit had been worked by the CCC camp. They had uncovered parts of five Proboscidean skeletons, including a number of tusks, lower jaws and parts of skulls. When their task of uncovering the large fossils was completed the entire deposit was swept away by a cloudburst; the only trace left was a few bits of ivory scattered along the stream bed. The teeth from the collection had been divided among the workers who would not part with them. It was reported that one small deposit of sand had yielded hundreds of teeth and small jaws, but these had been scattered and only a few isolated horse teeth of this collection were located. The locality was visited and found exhausted, but the careful sifting of their diggings yielded the fauna described in this paper.

The fauna is Upper Pliocene in age and younger than any taken from the Ogallala formation of Kansas in the past. The formation, upon close study, is found to be slightly different from that of the Middle Pliocene of Kansas. A large amount of clay is associated with the "Mortar" beds of the Upper Pliocene, and in the clay are sand pockets in which the fossils are found. All of the material found is rewashed and some of it shows signs of wear from stream transportation. The Proboscidean bones were not in place, but had

1. The study involving the description of this fauna has beeen aided by a grant from the University of Kansas Research Fund.

been washed in from the surrounding country at the time of deposition. Detailed discussion of the Upper Pliocene deposit will appear in another paper, since extensive work must be done in that area to determine its extent and relationship to the rest of the Ogallala. It is at least twenty feet in thickness in some places and extends over a large area. Most of the deposit is void of

Though the fauna is very fragmentary it represents the largest fauna taken from any one deposit in the Upper Pliocene of North America. It throws considerable light upon the ecology and distribution of the vertebrates of the high plains region at that time. The Pliocene fauna of the high plains region has been considered as occupying a dry plains region, either silghtly higher or lower than the present elevation. The known fauna and flora of the Middle Pliocene of Kansas existed in a more moist region than that found at the present time.

The Upper Pliocene fauna of Kansas presents an intermingling of what would be considered at the present time as three distinct faunas; (1) a southern fauna occurring in a region with a slightly greater rainfall and higher temperature; (2) a typical prairie fauna as it exists today in Kansas, and (3) a boreal fauna requiring a lower temperature and a greater rainfall than now exists in western Kansas. From a study of the microtine fauna one fact must be granted, that along these Upper Pliocene rivers a greater amount of vegetation occurred than now occurs along the same streams of Meade county, which means a greater rainfall. In this more humid area there existed a larger microtine fauna such as is now found in northeastern Kansas and probably at a lower temperature. The temperature at that time presents a problem. Did Sigmodon endure a slightly lower temperature than it does today or did a large microtine fauna thrive during the Upper Pliocene at a much higher temperature? Have some of the Microtinae been pushed back, as many have suggested, due to their inability to cope with other competitors at the close of the Pleistocene? Phenacomys and Sorex must be considered as representatives of an already established boreal fauna of that time. The occurrence of these forms in the Upper Pliocene establishes proof of their advance south and eastward, due to an already present climatic change brought about by the accumulation of ice and the climatic factors which caused the glaciation of the Pleistocene. It is far more logical to consider these forms as representative of a boreal fauna of that time, which had moved in to mingle with the more hardy forms of a southern fauna still remaining in that area, than to consider them as formerly existing in a warm, temperate, climate before the ice age, when they were part of another fauna; and at the close of the Pleistocene, having been pushed far to the north into a different life zone, because they could no longer compete with the other forms. The fauna shows the presence of wooded streams, wooded slopes and high grass land in Meade county at that time. The common water hole and the small prairie tributaries helped to bring together this collection of vertebrates from the Upper Pliocene.

The correlation of the fossil vertebrates from the Rexroad fauna of the Upper Pliocene from the Ogallala formation of Meade county, Kansas, depends largely upon future collecting of more complete specimens. The presence of *Equus* cf. *simplicidens, Nannippus* cf. *phlegon,* and the molar teeth of a longirostrine mastodon indicates the age as that of the Blanco of Texas. It

will take more than fragmentary material to tie these two faunas together, though the presence of Sigmodon may indicate a fauna as old as Benson. The microtone fauna, I believe, may be considered as slightly advanced over the Hagerman fauna. Due to the separation by the Rocky Mountains of the Rexroad fauna from the other western Upper Pliocene faunas—the closest relationship should be with the Blanco of Texas. I feel certain that it is safe to consider the fauna as old as the Blanco fauna, if not older.

I am greatly indebted to Mr. Charles D. Bunker, of the Kansas University Museum; Dr. C. L. Gazin and Dr. Gerritt S. Miller, Jr., of the United States National Museum for the loan of comparative materials; to Mr. R. A. Stirton, of the University of California for the identification of the horse material and helpful criticisms regarding the beaver material; to Dr. Erwin H. Barbour, of the University of Nebraska for identification of the Proboscidean material; to Dr. Edwin H. Colbert, of the American Museum of Natural History for information concerning Castoroides material, and to Dr. M. K. Elias of the Kansas Geological Survey for his information concerning the deposit and the fossils donated to the museum. I wish to thank Dr. H. H. Lane, Curator of Museums, and Dr. E. H. Taylor of the Department of Zoölogy of the University of Kansas, for numerous helpful criticisms and suggestions.

The drawings are by Maxim M. Elias of the University of Kansas, unless otherwise stated.

THE REXROAD FAUNA

Class PISCES

Order Percomorphi

Family CENTRARCHIDAE Sunfishes

A number of spines and vertebrae were found belonging to the family Centrarchidae.

Class AMPHIBIA

A number of limb bones and vertebrae were found, representing salamanders, frogs and toads. These are being studied by Dr. E. H. Taylor of Kansas University, who will publish data upon them in the near future.

Class REPTILIA

Remains of snakes, lizards and turtles were found associated with the other remains. These are also being studied by Doctor Taylor.

Class AVES

The largest collection of bird remains to be found in the Tertiary of Kansas was taken from this deposit. This material is very fragmentary and is being studied at the present by Dr. A. Wetmore of the United States National Museum.

CLASS MAMMALIA

Order INSECTIVORA

Sorex taylori sp. nov.

(Fig. 1)

Holotype.—No. 3906, University of Kansas Museum of Vertebrate Paleontology. Right lower jaw bearing alveoli of incisors and premolar; M_1, M_2 and M_3 present. Paratypes: University of Kansas Museum of Vertebrate Paleontology, No. 3907 right lower jaw bearing M_1; No. 3908 right lower jaw bearing M_1; No. 3909 right lower jaw bearing M_2; No. 3910 left lower jaw bearing M_2; and referred material No. 3911, right lower jaw bearing M_1 and M_2, and No. 3912 parts of two left lower jaws without teeth.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 2, Meade county, Kansas.

Diagnosis.—Protoconid appressing metaconid in M_1; M_2 and M_3 greater than in living species. All five cusps are developed in the molars; accessory cusps wanting; cingulum strongly developed; ascending ramus well developed; coronoid process high and narrow leaving the horizontal ramus at a right angle. M_3 nearer to ascending ramus than in living species.

Description of Type.—Lower jaw the size of that of *Sorex merriami* Dobson. In M_1, the paraconid-protoconid blade is not as deeply notched as in the living

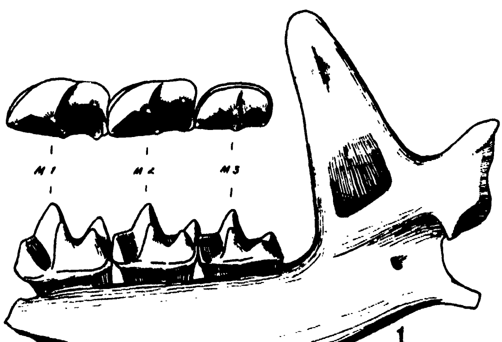

FIG. 1. *Sorex taylori* Hibbard, n. sp., holotype, showing lingual and crown view of right M_1, M_2 and M_3 of K.U.M.V.P., No. 3906, × 10.5.

species due to the appression of the metaconid by the protoconid which brings it considerably nearer the paraconid. The paraconid is not as well developed as in *Sorex merriami.* The hypoconid also appresses the entoconid. The trigonid is larger than the talonid; cingulum well developed; the anteroposterior length of M_1 is the same as that of *Sorex merriami* though the tooth has a shorter transverse diameter. There is a slight channel between the entoconid and the hypoconid blades. M_2 like M_1 with the exception that the paraconid-protoconid blades are more deeply notched and that the protoconid and metaconid are farther apart. The distance between the protoconid and

metaconid is less than in *S. merriami*. The entoconid is not as fully developed as in the living species; cingulum well developed; M_3 cusps well developed; hypoconid and entoconid better developed than in the living species, exceeding that of *Notiosorex*. M_3 closer to ascending ramus than in living species. Anterior edge of ascending ramus perpendicular to the horizontal ramus. Alveolus of premolar located well under the anterior part of M_1. Alveolus of the second incisor is crowded closely to the alveolus of the premolar. The alveolus of the first incisor is so situated that the external base of the tooth lies under the anterior region of M_1. This condition is also shown in the paratypes which agree with the type. No. 3910 is from an old adult the same size as the type, but in which the protoconids and metaconids are well separated as in the living species. This condition is not due entirely to wear, for No. 3907 and No. 3908 show greater wear than No. 3910 and in these jaws the metaconid has worn off at an angle leaving a gentle slope separating the protoconid and metaconid instead of the notch found in No. 3910.

GENUS? *Blarina*

A left lower I_1, No. 3913 may be referred to this genus. The tooth is as large as and of the same shape as that tooth in *Blarina*.

Order CARNIVORA

Mustelid sp.

No. 3916 is the left lower canine of a mustelid nearly as large as a badger.

Canidae sp.

(Plate 1, fig. 3)

No. 3914, fragmentary right jaw bearing P_4 and a part of M_1 represents a small dog with a light tapering ramus; anteroposterior diameter of P_4, 12 mm.; greatest transverse diameter of P_4, 4.9 mm.; alveolar length of P_3-P_4, 24.2 mm.; height of mandible below protocone of M_1, 15.5 mm.; height of mandible below diastema between P_2 and P_3, 12.5 mm.; greatest thickness of jaw below M_1, 8.2 mm.

No. 3915 is a left M^1 of a dog as large as *Canis nebracensis*. M^1 is distinctly different in that the inner half is considerably wider than in *Canis nebracensis* or other modern species of *Canis;* anteroposterior diameter of tooth, 13.4 mm.; transverse diameter of M^1, 15.1 mm.; anteroposterior diameter of inner half of M^1, 10.5 mm.

Machairodus sp.

(Plate 2, fig. 13)

No. 3917 is the left P_4 of a saber-toothed cat. This tooth is not advanced enough to be placed with *Ischyrosmilus;* anteroposterior diameter, 18.5 mm.

Felis sp.

No. 3918 is of a large canine tooth with only the base of crown present. A canine as large as that of *Felis atrox*.

Order Rodentia

Family SCIURIDAE

Citellus sp.

The genus *Citellus* is represented by two molars, No. 3929 representing a form about the size of *Citellus t. tridecemlineatus*. Also there are five molar teeth, No. 3931 representing a form of *Citellus* larger than *Citellus franklini*. Another form of *Citellus*, intermediate in size, is represented by five molar teeth, No. 3930.

Cynomys sp.

The genus *Cynomys* is represented by three molars, No. 3928, larger than the molars of *Cynomys l. ludovicianus*.

Eutamias or *Tamias* sp.

The genus Eutamias or Tamias is represented by a single P_4, No. 3925.

Family GEOMYIDAE

The family *Geomyidae* is represented by seven premolars all smaller than those of *Thomomys f. intermedius*. The crown pattern is peculiar.

Thomomys sp.

(Plate 8, fig. 19)

The genus Thomomys is represented by two premolars, No. 3926.

Family HETEROMYIDAE

(Plate 8, fig. 18)

This family is represented only by a single small upper premolar of a small *Perognathus*, No. 3935.

Family CASTORIDAE

Eocastoroides lanei gen. et sp. nov.

(Fig. 2)

Holotype.—No. 3843, University of Kansas Museum of Vertebrate Paleontology; fragmentary posterior portion of the left lower jaw of an old individual, with M_2 and M_3 in place. Referred material M_3, No. 3938. Locality No. 2.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 1, Meade county, Kansas.

Genotype.—*Eocastoroides lanei* Hibbard.

The characters of the genus are those of the type species.

Specific Diagnosis.—Strongly hypsodont prismatic cheek teeth with the base of the tooth open even in extremely old and heavily worn teeth. The dorsal surface of the lower incisor flat, passing along the lingual side of M_2 and directly under M_3 with the entire base of M_3 resting upon the flat dorsal surface of the incisor. M_2 and M_3 with hypostriid and mesostriid deep and extending to the base of the tooth. M_2 with anterior and posterior transverse diameter equal; S pattern. M_3 narrower posteriorly; S pattern indicated, though the posterior loop of enamel is separated entirely from the anterior

loops. Fossettids are absent on cheek teeth at hand. Masseteric fossa deep and well developed. Largest of the known Pliocene beavers.

Description of Type.—M_2 possesses an S pattern; anteroposterior diameter of crown, 11.9 mm.; greatest transverse diameter of crown, 9 mm.; length of tooth, 28 mm. The tooth is that of an old individual, completely hysodont with base open widely and no tendency toward closure or development of roots in extremely old age. Mesostriid and hypostriid present and deep, extending to base of the tooth. The mesoflexid and hypoflexid have nearly cut through the enamel. M_3, with S pattern indicated. The hypoflexid opening

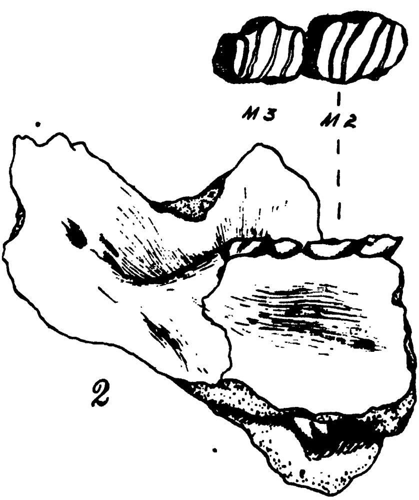

FIG. 2. *Eocastoroides lanei* Hibbard, n. gen. and sp., holotype, showing lingual and crown view of M_2 and M_3 of K.U.M.V.P., No. 3843, × 1.

through the lingual enamel wall of the hypostriid throughout its entire length. The mesoflexid has nearly cut through the enamel. The mesostriid and hypostriid are deep and extend to the open base of the completely hypsodont tooth. M_3 is narrower posteriorly than anteriorly; anteroposterior diameter of crown, 9.5 mm.; transverse diameter of crown, 9 mm.; length of tooth, 17 mm. The masseteric fossa is deep and strongly developed. The distance from the labial edge of M_3 to the base of the ascending ramus at the point of the attachment of the *masseter-temporalis anterior* muscle is 15 mm.; while that of a large specimen of *Castor c. carolinensis* is 9 mm. The inferior dental foramen of *Eocastoroides lanei* presents 3 openings. The most dorsal opening is the size of the inferior dental foramen in *Castor c. carolinensis*; slightly anterior and ventral are two more openings, the one more lingual being the larger. The root of the incisor in *Eocastoroides lanei* has a flattened dorsal surface with a width of 11 mm. at the base of M_3. The root of the incisor passes directly under the base of M_3, while in *Castor* it passes at the labial edge of the base of M_3 and is rounded.

Discussion.—*Eocastoroides lanei* is a form that possesses characters of both *Dipoides* and *Castoroides*, but with more characters like the latter. It will be

interesting to know whether the lower incisors are smooth as in *Dipoides* or grooved as in *Castoroides*. It is a form that bridges well the gap between *Dipoides* and *Castoroides*. To give rise to *Castoroides* it would have only to complete the separation of the enamel loops, and shift lower incisor so that it would be more lingual to M_3 instead of passing directly along the lingual border of M_2 and directly under M_3.

Eocastoroides is too far advanced and specialized ever to give rise to the genus *Castor* or to have a very close relationship.

In the collection there are two upper cheek teeth No. 3939, and No. 3940 from locality No. 2, which represent a smaller beaver. From their size they are too small to be associated with the species just described. If they do belong to the same species it is a form that varies greatly in size. These isolated teeth are of an adult and are well worn.

Tooth No. 3939 (see plate 3, fig. 16), strongly curved, extremely hypsodont, with base of tooth larger than crown; parastria weakly developed, mesostria and hypostria strongly developed; all striae extending to base of the tooth. The metaflexus and mesoflexus are tightly appressed against the lingual enamel wall. Tooth No. 3940 has the same structure as No. 3929 with the exception that only the mesostria is present and not as deeply developed, though it extends to the base of the tooth. The hypostria is also weakly developed. This may be due to the fact that the tooth is not as greatly worn as No. 3939.

FAMILY CRICETIDAE

Two or three genera of this family besides the genus *Peromyscus* are represented by 15 isolated molars.

Peromyscus ēliasi sp. nov.

(Plate 1, fig. 4)

Holotype.—No. 3941, University of Kansas Museum of Vertebrate Paelontology. Portion of left mandible with M_1, M_2 and M_3; incisor, angle, condyle and coronoid process missing. Referred material; No. 3942, 2 right M^1, one left M^1, one left M_1 and a portion of right mandible with M_1.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 2, Meade county, Kansas.

Diagnosis.—A *Peromyscus* the size of *Peromyscus m. osgoodi,* with a slightly heavier mandible, which is deeper below M_2 and M_3. The diastemal region of the lower jaw is heavier with the mental foramen more nearly on the dorsal surface. Cusps not as nearly closed as in the modern forms with broader lophids connecting the cusps.

Description of Type.—The mandible is that of an old specimen with teeth greatly worn, only the outlines of the cusps remaining. The valleys between the cusps are deeper than those of modern forms showing the same amount of wear. The lophids are broader giving rise to larger dentine tracts. Anteroposterior diameter of M_1-M_3 series is 3.7 mm.

The referred teeth are those of adult specimens showing different stages of wear. These give a clear detail of dentition pattern and agree with the type. They are the same size as the teeth of the type.

This species is named in honor of Dr. M. K. Elias, of the Kansas Geological Survey, who has greatly assisted in locating the Pliocene fossil beds in Kansas.

Sigmodon intermedius sp. nov.

(Plate 1, fig. 8)

Holotype.—No. 3887, University of Kansas Museum of Vertebrate Paleontology. Portion of left mandible with incisor, M_1, M_2 and M_3; angle, condyle, and coronoid process missing. Referred material, two left M^1, 11 lower molars and right mandible with M_1 and M_2.

Horizon and Type Locality.—Upper Pliocene of the Ogallaha formation, Rexroad fauna, Locality No. 2, Meade county, Kansas.

Diagnosis.—Intermediate in size between *Sigmodon curtisi* and *Sigmodon medius*. Distinguished from other fossil and living forms in that the anterior internal lophid of M_2 is not as compressed and transversely elongated. Anterior to the posterior loop of M_2 and on the lingual side of the tooth is found an enamel islet. In young specimens this islet is represented by a well-developed reëntrant fold, but not deep enough to persist through the wearing life of the crown; a distinctive character of this form. The anteroposterior diameter of this lophid is nearly as great as its transverse diameter due to the angulation of the antero-external portion of this tooth. The anterior loop of M_1 large. The antero-internal lophid of M_1 opens widely into the anterior loop.

Description of Type.—The mandible is that of an adult specimen showing considerable wear. Anteroposterior diameter of crown series of M_1, M_2 and M_3, 5.5 mm.; greatest depth of jaw from crown to base of ramus, 5.8 mm.; distance from anterior alveolus of M_1 to posterior border of incisor alveolus, 3.5 mm.; mental foramen normal. The dentition differs from that of the living species in that the reëntrant valleys are wider and the molars are not so crowded, giving the fossil teeth a more rounded appearance. The primitive structure of M_2 of this form is diagnostic, for in the young specimens it consists of a posterior loop and two distinctive internal lophids. The posterior reëntrant valley disappears with wear leaving only the isolated islet in the well worn crown of the adult.

Sigmodon intermedius presents the most primitive dentition found among the cotton rats. M_2 throws considerable light upon the evolutionary development of that tooth and presents a picture of the more primitive dentition of its ancestors.

Subfamily Microtinae

Pliolemmus antiquus gen. et sp. nov.

(Plate 1, fig. 7)

Holotype.—No. 3889, University of Kansas Museum of Vertebrate Paleontology. Portion of right mandible, with complete incisor, M_1 and M_2; M_3, angle, condyle and coronoid process missing. Referred material left M_1 and right M_1.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 1, Meade county, Kansas.

Genotype.—*Pliolemmus antiquus* Hibbard. The characters of the genus are those of the type species.

Diagnosis.—A small primitive lemming with completely hypsodont teeth, their reëntrant folds lacking cement. M_1, M_2 and M_3 labial to base of incisor.

Incisor extending well past M_3 on lingual side. M_1 consisting of a posterior loop, seven alternating triangles nearly closed, and a simple anterior loop. M_2 consists of a posterior loop and four alternating triangles. The enamel is not differentiated into thin or thick tracts.

Description of Type.—The teeth are rootless with open base, their reëntrant folds lacking cement. The incisor is lingual to the roots of the molars; it extends 4 mm. past the posterior border of M_2. M_1 consists of a posterior loop, seven alternating triangles and a simple anterior loop. The triangles are nearly closed, with the exception of the most anterior, which opens rather widely into the anterior loop. The enamel of the salient angles is of uniform thickness and not differentiated into thin and thick tracts. There are five outer and six inner salient angles; the inner salient angles being slightly larger, the fifth anterior salient angle slightly the smallest. M_1 is concave on the labial side and convex on the lingual; anteroposterior diameter of crown, 2.5 mm. M_2 consists of a posterior loop and four alternating triangles. The anterior outer salient angle slightly rounded. M_2 has a greater concavity and convexity than M_1. Anteroposterior diameter of crown of M_2, 1.6 mm. M_3 missing, but considering it the size of M_2 the lower incisor extended at least 2 mm. past its posterior edge. It appears to have had a greater concavity on its lingual side than M_2. The mental foramen is situated dorsally on the ramus, so that a line drawn from the middle of the anterior loop of M_1 to the middle of the incisor at the base of its alveolus would pass along its lingual border.

Discussion.—*Pliolemmus antiquus* represents the most primitive of the lemmings: (1) in its simple tooth structure; (2) greatly elongated base of the incisor; (3) dorsally located mental foramen. It shows a greater relationship to *Dicrostonyx* than to any of the other genera of lemmings in the number of alternating triangles and less reduced incisor root.

Genus *Phenacomys* Merriam, North American Fauna No. 2, p. 28, October 30, 1889. Genotype.—*Phenacomys intermedius* Merriam. Subgenus *Phenacomys* Merriam.

Pliophenacomys subgen. nov.

Phenacomys primaevus sp. nov.

(Plate 1, fig. 5)

Holotype.—No. 3905, University of Kansas Museum of Vertebrate Paleontology. Right lower jaw bearing incisor, M_1, and M_2, with alveolus of M_3; lacking angle, condyle and coronoid process. Referred material left M_1 and M_3.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 2, Meade county, Kansas.

Type of the Subgenus.—*Pliophenacomys; Phenacomys primaevus* Hibbard. The characters of the subgenus are those of the type species.

Diagnosis.—A vole the size of *Phenacomys u. ungava* Merriam, possessing a more primitive dentition than found in the living species. The mental foramen is located dorsally on the ramus instead of on the dorsal labial side of the ramus as in the living forms. Teeth brachyodont; cement absent in reëntrant folds; M_1 with posterior loop, five alternating closed triangles, the sixth alter-

nating triangle opens widely into the anterior loop. The enamel is slightly differentiated into thinner tracts on the posterior side of the triangles. M_2 with posterior loop and 4 alternating closed triangles. The lower incisor crosses from the lingual side of the jaw to the labial side under M_3.

Descriptive of Type.—Teeth brachyodont, lacking cement in reëntrant folds. The lower incisor crosses from the lingual side of the jaw to the labial side under M_3. The posterior root of M_3 rests on the dorsolingual side of the incisor. The incisor extends well past M_3, but due to the broken condition of the jaw the exact posterior position is unknown. The enamel of the teeth shows a slight differentiation, with the posterior edge of the triangle slightly thinner than the dorsal edge. M_1 consists of a posterior loop, 6 alternating triangles and an anterior loop. The posterior loop is more primitive in structure than that found in any living form, being more angular and not possessing as great transverse width. The first 5 alternating triangles are closed but not as tightly as in the living forms, but the alternating triangles are smaller, having a more acute angle. The inner triangles are larger than the outer. The second outer triangle shows but a slight tendency toward an increase in the anteroposterior diameter while this condition is quite noticeable in the living species. The sixth alternating triangle or third outer angle opens widely into the anterior loop. M_1, anteroposterior diameter, 2.8 mm., transverse diameter, 1.2 mm. M_2 consists of a posterior loop and 4 alternating closed triangles. The posterior loop has an acute angle and not rounded as in the living species, its transverse diameter is also less. The alternating triangles possess the sharply acute angles as in M_1. M_2, anteroposterior diameter, 2 mm. M_3 missing, but the alveolus shows that the two roots were well developed. Alveolar length of M_1—M_3, 6.2 mm. Distance from anterior alveolar border of M_1 to the posterior border of alveolus at the base of the incisor, 3 mm. The mental foramen is situated more dorsally on the ramus than in the living species. This seems to be a tendency that existed in other primitive forms of the *Microtinae*.

Pliopotamys meadensis gen. et sp. nov.

(Plate 1, fig. 9)

Holotype.—No. 3846, University of Kansas Museum of Vertebrate Paleontology. Portion of right mandible with incisor, M_1 and M_2; angle, condyle and coronoid process missing. Referred material left M_1.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 2, Meade county, Kansas.

Genotype.—Pliopotamys meadensis Hibbard.

The characters of the genus are those of the type species.

Diagnosis.—A medium sized vole slightly smaller than *Neofiber*. Molars brachyodont; cement absent in reëntrant folds; M_1 and M_2 each having two well-developed roots. M_1 with posterior loop, five alternating triangles and anterior loop of simple structure. The triangles are closed with the exception of the anterior which is nearly closed. Outer triangles considerably smaller than the inner triangles; anteroposterior diameter of crown, 4.5 mm. M_2 with posterior loop and four alternating triangles, with third and fourth nearly separated by the enamel of the reëntrant angle; anteroposterior diameter of the crown, 2.5 mm. The base of the lower incisor crosses under the roots of M_3

from the lingual to the labial side of the jaw. Anteroposterior alveolar diameter of M_1—M_3, 10 mm. The mandible distinctly lacks the well developed ridge for the attachement of *masseter medialis* muscle. Attachment as poorly developed as in Evotomys.

Description of type.—The roots of M_1 are strongly developed, the anterior being nearly twice as large as the posterior. The enamel is thick, but not differentiated into thin or thick tracts. The enamel pattern suggests that of *Phenacomys* more than any other form. It is distinguishable from the latter by the more shallow reëntrant folds on the inner side and by the character of the posterior and anterior loop of M_1. M_2 with two roots, the anterior more strongly developed. Three salient angles on each side, the anterior outer salient angle being greatly reduced and nearly separated from the anterior inner salient angle. M_3 though absent had two well-developed roots; the anterior being slightly larger. The lower incisor passes from the lingual to the labial side of the jaw under M_3. The anterior root of M_3 rests on the dorsal surface of the incisor. The posterior root has shifted enough lingually to rest upon the side of the mandible. The mandible is light for its size. The masseteric ridge is poorly developed. The groove between the molars and the ascending ramus is open posteriorly as in Evotomys. Mental foramen normal.

Discussion.—Pliopotamys is distinguishable from *Mimomys, Arvicola* and *Cosomys* by its distinctive dental pattern, poorly developed masseteric ridge on the outer side of the ramus, the simple construction of the anterior loop of M_1 and the advanced development of closed triangles.

In the outstanding work of Martin A. C. Hinton, "Monograph of the Voles and Lemmings (Microtinae) Living and Extinct," a careful description and illustrations are given of the species of Mimomys and Arvicola which show the gradation of one form into the other. The one distinctive character stressed throughout the discussion is that of constant dental pattern. I wish to call attention to the anterior outer triangle and the inner anterior triangle of M_2 and their characteristic contact pattern with the posterior loop of M_1. In every figure of these forms except figure 100 (cheek teeth of Mimomys) subfigure 12, p. 360, there is a square cut contact of M_2 with the posterior loop of M_1. This constant character should be considered with other generic characters of these genera, as one of the outstanding distinguishable features. Placing our American genus Cosomys in synonomy with Mimomys at once brings disaster to that distinctive tooth pattern of Mimomys and Arvicola. Until a series is found to bridge completely the gap it seems far better to consider Cosomys distinct. Though Hinton, in the "Journal of Mammalogy" 13:280-281, points out that the form *Cosomys primus* is a little more primitive than *M. plioceanicus,* and that it has a tooth pattern such as would be expected in an ancestor of our later species, in this country, no form has yet been discovered to indicate the tooth pattern of the European Mimomys. Thus far the study of our forms supports Hinton's point of view that a larger percent have arisen from a primitive Phenacomys-like ancestor. We now find Phenacomys well on the road to the condition existing in our modern genus associated with these many extinct forms.

Neondatra kansasensis gen. et sp. nov.

(Plate 1, fig. 6)

Holotype.—No. 3847, University of Kansas Museum of Vertebrate Paleontology. Portion of left mandible with base of incisor; M_1, and M_2; angle, condyle and coronoid process missing. Referred material, two right lower molars and an associated left M_3.

Horizon and Type Locality.—Upper Pliocene of the Ogallala formation, Rexroad fauna, Locality No. 2, Meade county, Kansas.

Genotype.—*Neondatra kansasensis* Hibbard.

The characters of the genus are those of the type species.

Diagnosis.—A medium sized vole. Teeth brachyodont; cement not present in reëntrant folds (may have been lost during preservation). M_1 with posterior loop, five alternating triangles not closed, with the fifth opening widely into the complicated anterior loop; salient angles acute, showing no tendency toward rounding; anterior root larger than posterior; crown length, 4.5 mm. M_2, with posterior loop and four alternating triangles, not closed; outer anterior salient angle nearly closed and reduced; anteroposterior diameter of crown, 2.5 mm. Alveolus of M_3 crowded lingually, the posterior root larger than anterior. Lower incisor crosses from the lingual side to the labial side of the jaw under the posterior root of M_2 and the anterior root of M_3 instead of between M_2 and M_3. Well developed masseteric ridge on labial side of jaw. Alveolar length of M_1-M_3, 10 mm.

Description of Type.—The jaw is that of an adult specimen showing a well-worn crown. *Neondatra kansasensis* is intermediate in size, slightly larger than *Ondatra i. minor* and smaller than *O. i. idahoensis*. M_1 is composed of a posterior loop, five alternating triangles and a complicated anterior loop. There is a tendency for the development of a fourth external reëntrant fold. This, of course, will disappear in extremely old age, due to the strongly brachydont character of the tooth. The external salient angles are considerably smaller than the inner salient angles. The enamel is not differentiated into thin or thick tracts. The fourth and fifth triangles have a well developed posterior convexity, which is not noticeable in the other triangles. The second and third triangles exhibit a slightly concave face which is entirely lacking in the others. M_2 consists of a posterior loop and 4 alternating triangles. Triangles 3 and 4 are nearly closed, though the third inner salient angle has shifted forward and nearly opposite the third outer salient angle, a condition showing specialization. The posterior root of M_2 is well-developed and rests directly on the dorsolateral side of the incisor and not labial to the incisor. M_3 is represented only by the alveolus. The posterior root is considerably larger. The anterior root has been reduced due to the fact that it rests directly on the dorsolabial side of the incisor instead of having shifted labially. The ramus is heavily built with a well-developed masseteric ridge along the labial side. There is a slight pocketing in the posterior region of the groove between the molars and the ascending ramus. Mental foramen normal. It is important to note that a prominent ridge is developed on the lingual side of the alveolar border in the posterior region. This is more pronounced than in any of the other genera examined.

Discussion.—In size *Neondatra kansasensis* corresponds to *Pliopotamys meadensis*. The dental pattern is nearly the same with the exception of the

outstanding simple structure of the anterior loop of M_1 of the latter and the complicated structure of the anterior loop of M_1 of the former. The relation of the incisors to M_2 and M_3, also the size of the mandible, which in *Neondatra kansasensis* is strongly developed, as compared with *Pliopotamys meadensis* which has a lighter mandible with the many other outstanding differences noted above are characters which separate these two forms at once.

It seems proper to question the generic relationship of *Ondatra i. idahoensis* and *O. i. minor.* The character of the open triangles and the other dental differences seem to separate them without question from the genus *Ondatra.* A careful study should be made of these forms, with regard to the relationship of the lower incisor to M_2 and M_3.

In the case of *Neondatra kansasensis,* the dental pattern and the development of the third and fourth triangles of M_2 give a form well specialized and not in the direct line of development as an ancestor to the genus Ondatra.

In this locality over 75 isolated teeth were collected belonging to the Microtinae. The teeth range from 3 rooted brachyodont types to old worn hypsodont types, varying in size from the smallest voles to the smallest living forms of Ondatra. Two M_2 are in the collection representing without question a distinct Ondatra pattern. These are not described at this time because it is hoped that more abundant material from the locality will throw a greater light upon living and fossil forms. But it is known that these forms have segregated themselves into distinct genera at this time and are well on the road to many of the living genera. It is evident that there were many primitive forms existing at that time which will not fall into the modern grouping.

Order LAGOMORPHA

FAMILY LEPORIDAE

Hypolagus sp.

(Plate 3, fig. 15)

This genus is represented by a right upper molar, No. 3923; a right lower molar M_1 or M_2 and two lower M_3, No. 3924. These teeth are as large as those of *Lepus alleni alleni.*

Order PERISSODACTYLA

FAMILY EQUIDAE

Nannippus cf. *phlegon* (Hay).

(Plate 4, fig. 21, a-c)

Referred Material.—From Locality No. 1, and Locality No. 2, 52 premolars and molars were taken of this extremely hypsodont little horse. A number of incisors were found associated with the molars and premolars.

Equus (*Plesippus*) cf. *simplicidens* Cope

(Plates 2, 5, figs. 10-12, 22 a-c)

Referred Material.—From Locality No. 1 and No. 2 there were collected 58 premolars and molars referable to this species. Among these teeth there are 10 that could be referred to *Equus cumminsi* Cope, though they are probably heavily worn teeth of small individuals of *Equus* cf. *simplicidens.* In a number of details the dentition pattern differs from that of *E. simplicidens* as

figured by Cope, though it may be entirely an individual variation. More complete material of the horses is needed to determine their true relationship with those of the Blanco fauna.

Order Artiodactyla

Family TAYASSUIDAE

Platygonus sp.

(Plate 2, figs. 14 a-b)

To this genus may be referred 6 premolars No. 3919. They agree in many details with Platygonus material from the Blanco.

Family ANTILOCAPRIDAE

Genus? *Capromeryx*

(Plate 3, fig. 17)

In the material are 4 teeth No. 3943 belonging to an antilocaprid. They are not characteristic enough to determine with certainty their taxonomic position.

Family CAMELIDAE

Camelops sp.

(Plate 3, fig. 20)

In the collection are 2 large incisors and an M^2, No. 3944, belonging to this genus. These were the only camel remains found.

Order Proboscidea

Subfamily Longirostrinae

Proboscidean remains were abundant in the formation, but due to their large size they had been removed by the CCC workers. Only 4 molar teeth were secured. All of these belong to the subfamily *Longirostrinae*. No. 3860, two molar teeth; No. 3861, upper molar of a *Trilophodont* mastodon and No. 3862, a third molar.

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PLATE I

Fig. 3. *Canidae* sp., labial view of right jaw showing P_4 and M_1 of K.U.M. V.P., No. 3914, $\times$ 1.

Fig. 4. *Peromyscus eliasi* Hibbard, n. sp., holotype, showing crown view of left M_1, M_3 of K.U.M.V.P., No. 3941, $\times$ 10.

Fig. 5. *Phenacomys primaevus* Hibbard, n. sp., holotype, showing crown view of right M_1 and M_2 of K.U.M.V.P., No. 3905, $\times$ 8.

Fig. 6. *Neondatra kansesensis* Hibbard, n. gen. and sp., holotype, showing crown view of left M_1 and M_2 of K.U.M.V.P., No. 3847, $\times$ 8.

Fig. 7. *Pliolemmus antiquus* Hibbard, n. gen. and sp., holotype, showing crown view of right M_1 and M_2 of K.U.M.V.P., No. 3889, $\times$ 10.

Fig. 8. *Sigmodon intermedius* Hibbard, n. sp., holotype, showing crown view of left M_1, M_3 of K.U.M.V.P., No. 3887, $\times$ 13.

Fig. 9. *Pliopotamys meadensis* Hibbard, n. Gen. and sp., holotype, showing crown view of right M_1 and M_2 of K.U.M.V.P., No. 3886, $\times$.

PLATE I

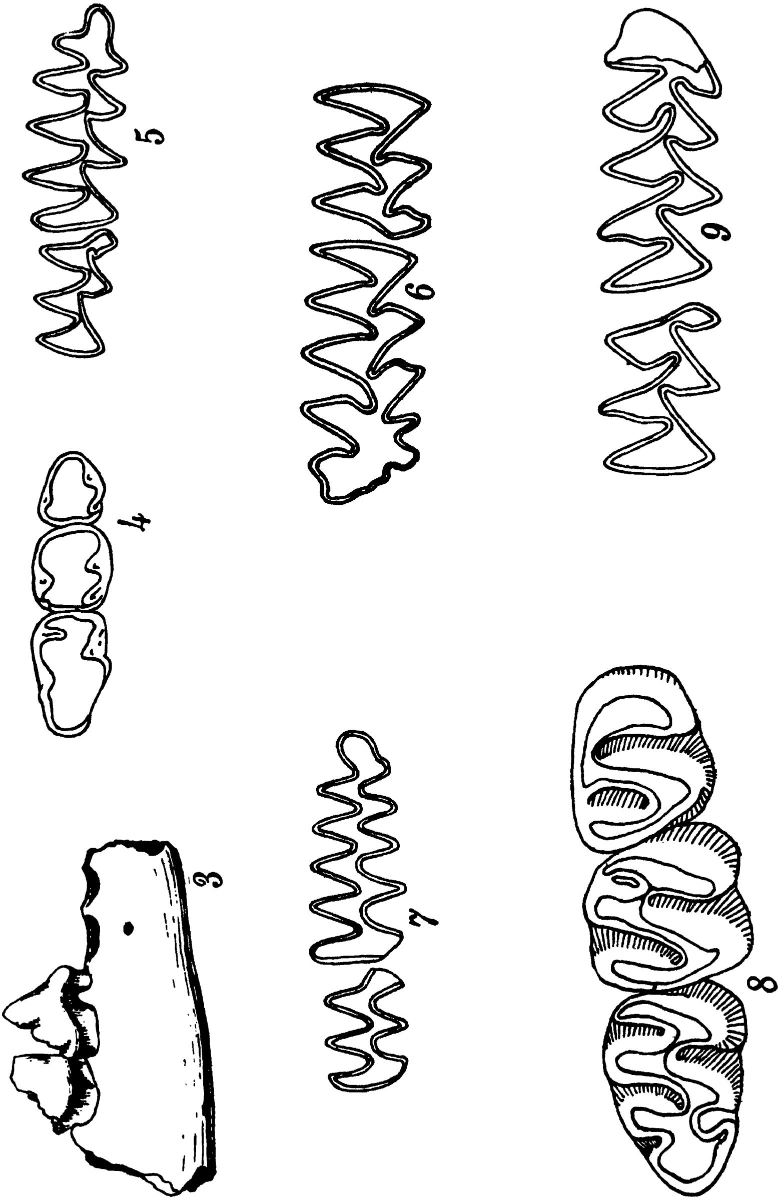


PLATE II

FIGS. 10-12. *Equus* (*Plesippus*) cf. *simplicidens* Cope. Fig. 10. Labial and crown view of right P^2 of K.U.M.V.P., No. 3951, $\times$ 1; fig. 11, labial and crown view of left P^3 of K.U.M.V.P., No. 3950, $\times$ 1; fig. 12, labial and crown view of left M^1 of K.U.M.V.P., No. 3953, $\times$ 1.

FIG. 13. *Machairodus* sp., left P_4, of K.U.M.V.P., No. 3917, $\times$ 1.

FIGS. 14a and 14b. *Platygonus* sp. Side and crown view of upper premolars of K.U.M.V.P., No. 3919, $\times$ 2. Drawings by Harold Alexander.

PLATE II

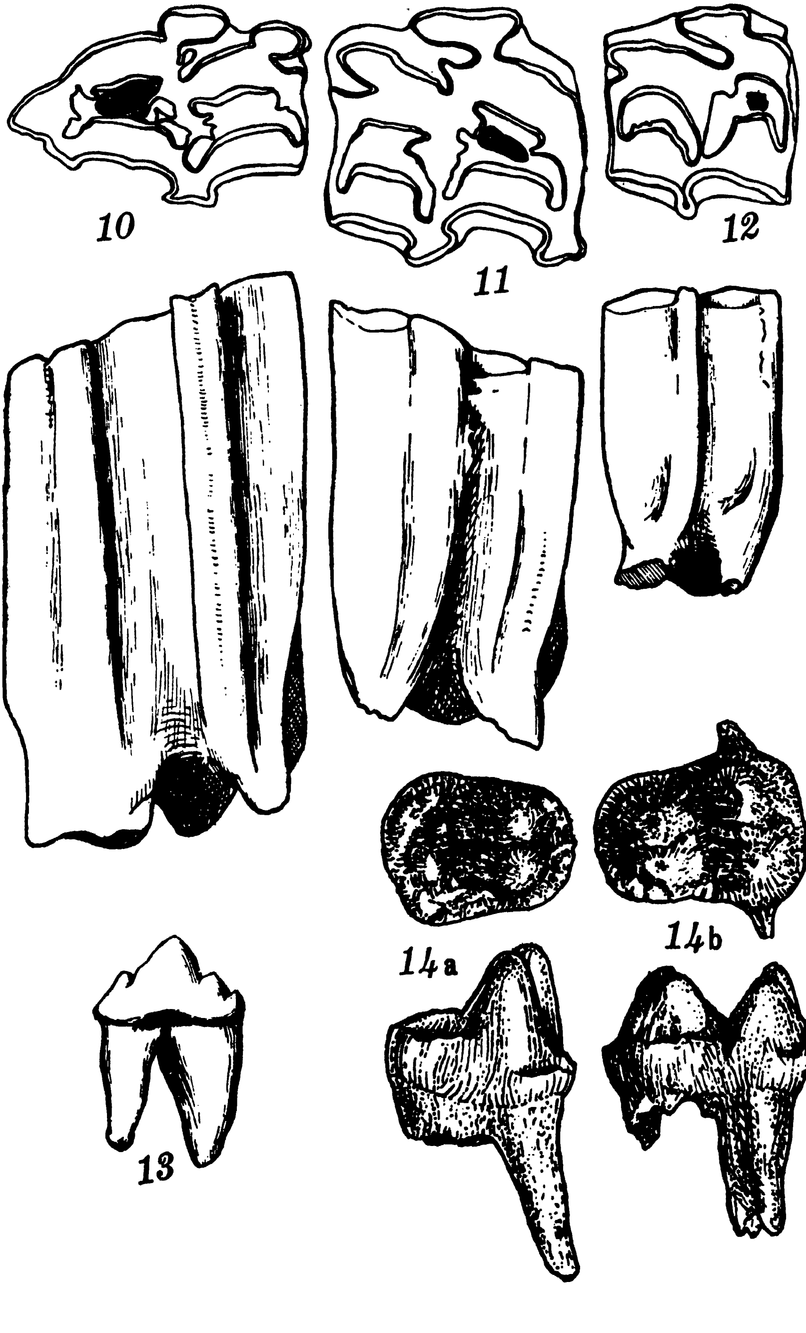


PLATE III

FIG. 15. *Lepus* sp., side and crown view of right upper molar of K.U.M.V.P., No. 3923, × 4.

FIG. 16. *Eocastoroides* sp., side and crown view of upper cheek tooth of K. U. M. V. P., No. 3939, × 4.

FIG. 17. Genus? *Capromeryx,* showing side and crown view of K.U.M.V.P., No. 3943, × 2.

FIG. 18. *Perognathus* sp., showing crown view of upper premolar of K.U.M. V.P., No. 3935, × 10.

FIG. 19. *Thomomys* sp., showing side and crown view of premolar of K.U. M. V. P., No. 3926, × 8.

FIG. 20. *Camelops* sp. Labial and crown view of M^2 of K.U.M.V.P., No. 3944, × 1. Drawings by Harold Alexander.

PLATE III

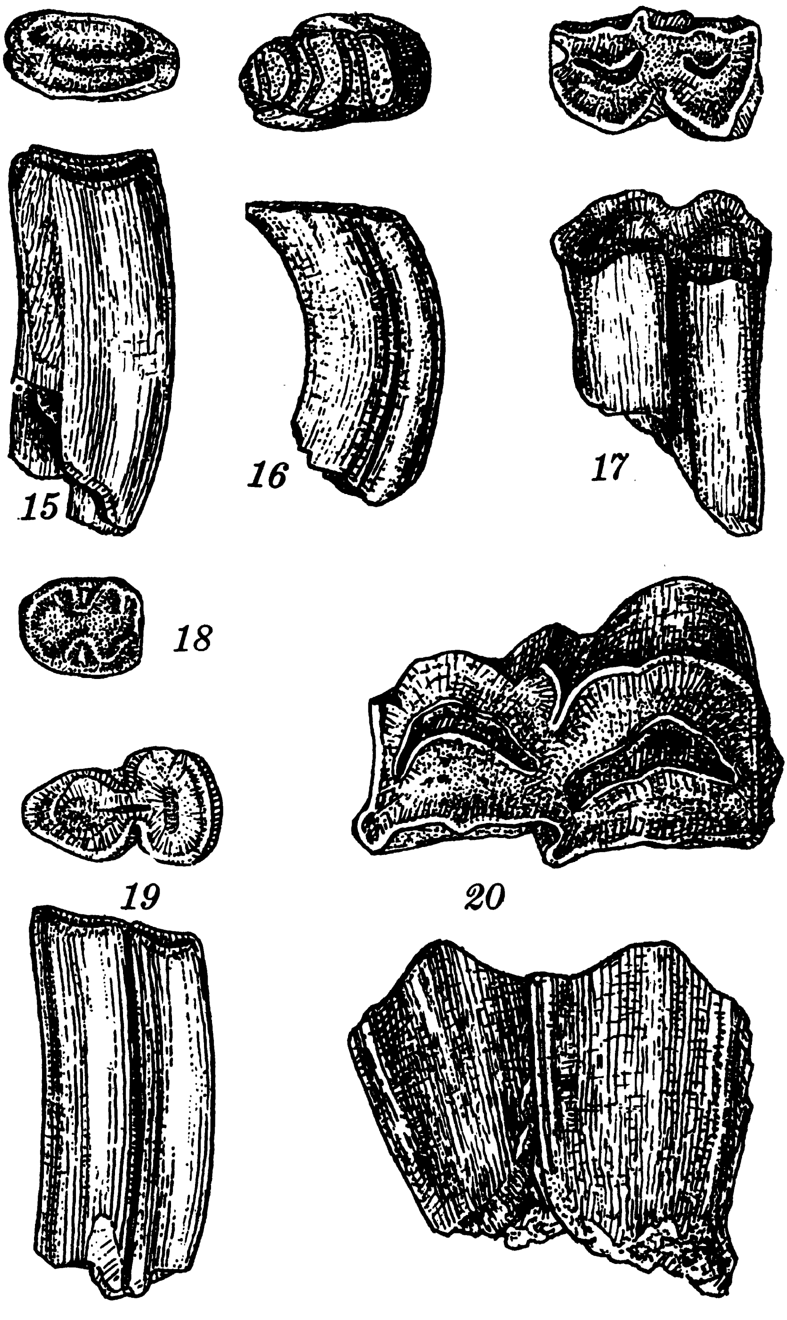


PLATE IV

Nannippus cf. *phlegon* (Hay)

FIG. 21a. Lingual and crown view of right M_1 of K.U.M.V.P., No. 3956A, $\times$ 1.

FIG. 21b. Labial and crown view of right upper molar of K.U.M.V.P., No. 3956B, $\times$ 1.

FIG. 21c. Labial and crown view of right upper molar of K.U.M.V.P., No. 3956C, $\times$ 1.

FIG. 21d. Labial and crown view of right upper molar of K.U.M.V.P., No. 3956D, $\times$ 1.

FIG. 21e. Lingual and crown view of right P_2 of K.U.M.V.P., No. 3956E, $\times$ 1.

PLATE IV

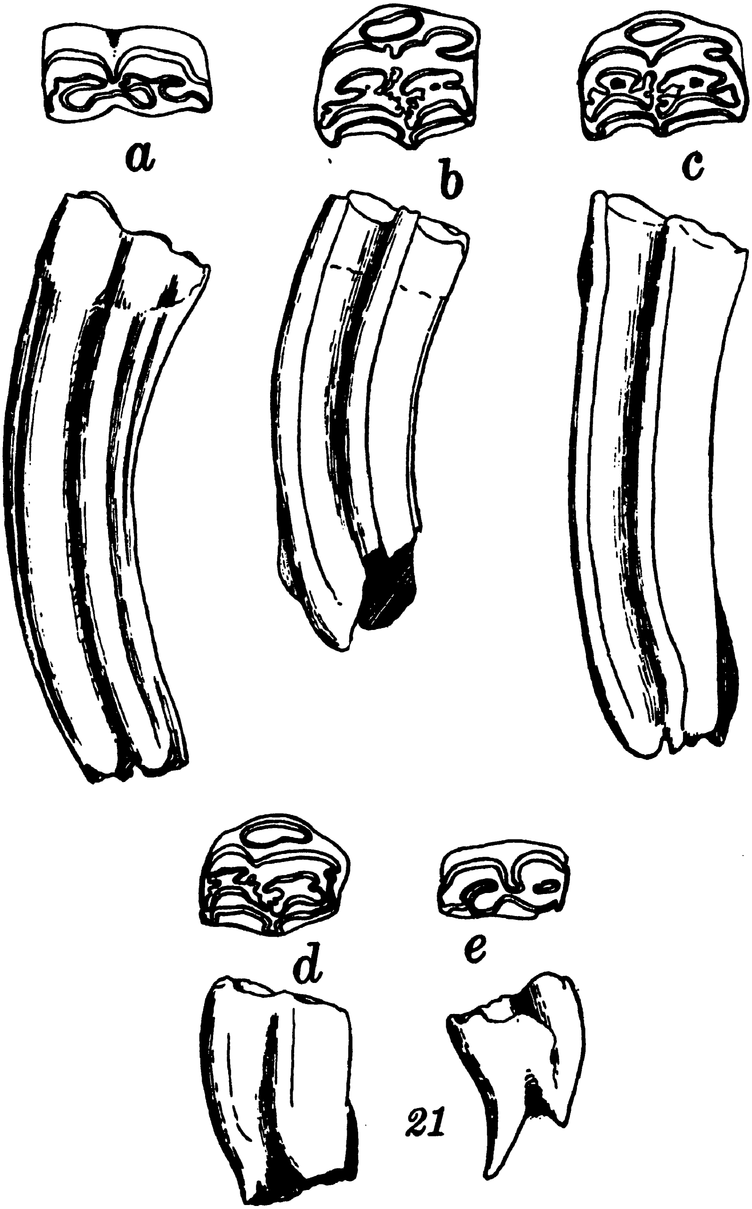


PLATE V

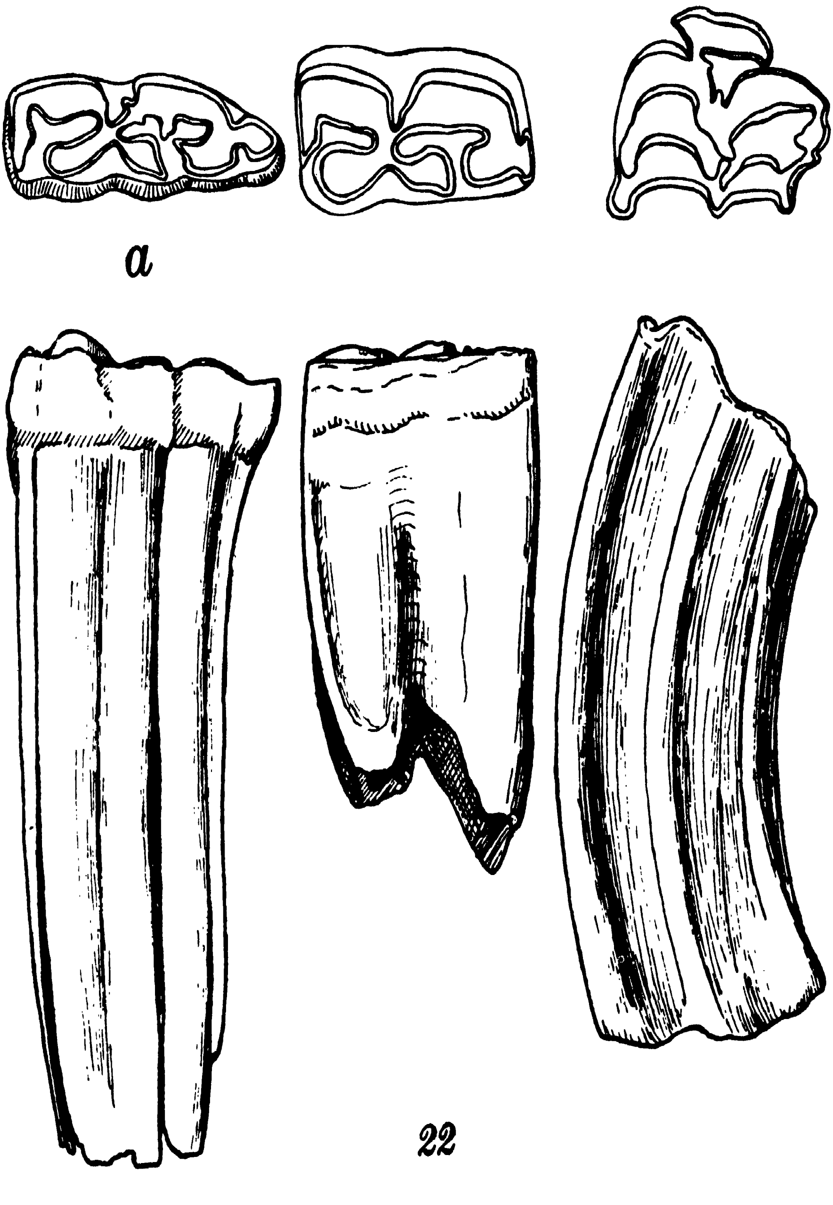
Equus (*Plesippus*) cf. *simplicidens*

FIG. 22a. Lingual and crown view of right M_1 of K.U.M.V.P., No. 3952, $\times$ 1.

FIG. 22b. Lingual and crown view of right P_3 of K.U.M.V.P., No. 3955, $\times$ 1.

FIG. 22c. Labial and crown view of left M^3 of K.U.M.V.P., No. 3954, $\times$ 1

PLATE V



Glacial Striae in Kansas: Locality 19

WALTER H. SCHOEWE, University of Kansas, Lawrence, Kan., and ARTHUR BRIDWELL, Baldwin, Kan.

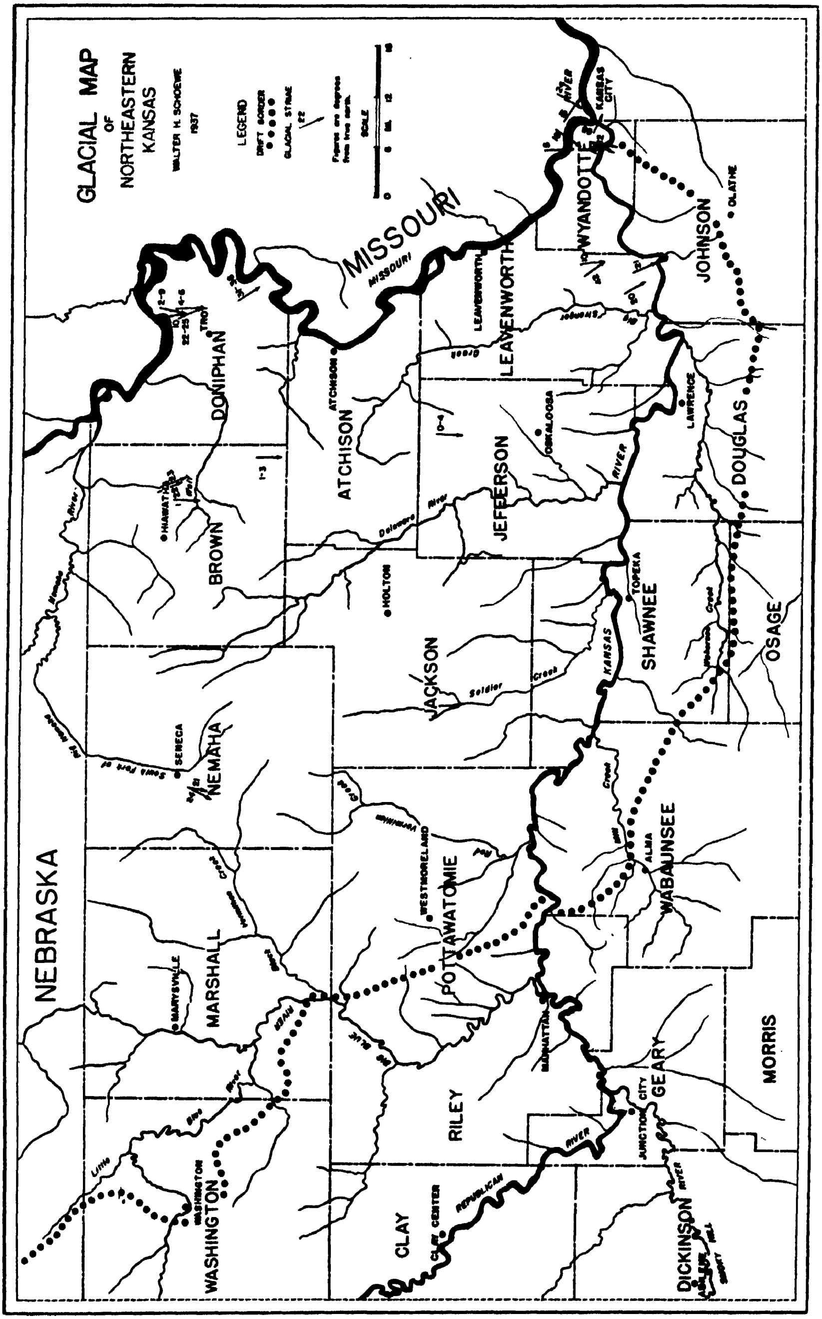
Prior to 1930 there were six localities distributed in four counties in Kansas where the planing and scouring effects of a great continental ice sheet were recorded by glacial striae and grooves. The first glacial striae were discovered by L. C. Wooster in Nemaha county in 1892. The next five striated bedrock surfaces were recorded in the period between 1910 and 1916, and the remaining thirteen localities were discovered between 1930 and 1936.

The purpose of this note is to record the nineteenth locality in Kansas where glacial striae are present. The striae occurr in Jefferson county in the NW. cor. NE.¼ of sec. 20, T. 8 S., R. 19 E., and are the first ones to be recorded for that county. The striae trend S. 0 to 4° W. and mark the upper surface of the Coal Creek limestone member of the Topeka limestone formation. Not only is the limestone striated, but it is also planed smooth to a glacial pavement. Overlying the striated bedrock is a grayish sandy to clayey Kansan till. This new locality was discovered by the junior author in April, 1936. A short account of the discovery was reported in the Kansas City *Star*.

A summary of the glacial striae in Kansas is given below, together with a map showing their locations and trend. For a description of localities in Kansas where glacial striae occur, together with other data pertaining to them, the reader is referred to Kansas Academy of Science, Transactions, 34:145-147, 1931; 35:223, 1932; and 36:141, 1933. In this connection, three localities in Kansas City, Mo., should be mentioned where glacial striae occur. Of these, two are north of the Missouri river and one south. (See Schoewe, W. H., Glacial Geology of Kansas. Pan-American Geologist, 40: Plate 11, 1923; Todd, J. E.: Formations of the Quaternary Deposits. Missouri Geological Survey, 10:121, 1896; Jewett, J. M.; A Newly Found Locality of Glacial Striae South of Missouri river. Trans. Kan. Acad. of Sci., 37:153, 1933.)

SUMMARY OF GLACIAL STRIAE IN KANSAS

County.	Number localities.	Year discovered.	Discoverer.
Nemaha	1	1892	Wooster
Leavenworth	2	1916	Todd, Jewett, Newell
Wyandotte	6	1916, 1930	Todd, Jewett, Newell, Darton
Douglas	1	1910–1916	Twenhofel
Brown	5	1930, 1932	Schoewe
Doniphan	3	1930, 1933	Schoewe
Jefferson	1	1936	Bridwell


GLACIAL MAP
OF
NORTHEASTERN
KANSAS
WALTER H. SCHOEWE
1937
LEGEND
DRIFT BORDER
GLACIAL STRIAE
SCALE
NEBRASKA
MISSOURI
WASHINGTON
MARSHALL
NEMAHA
BROWN
DONIPHAN
ATCHISON
JACKSON
JEFFERSON
LEAVENWORTH
WYANDOTTE
JOHNSON
DOUGLAS
SHAWNEE
OSAGE
WABAUNSEE
POTTAWATOMIE
RILEY
CLAY
GEARY
MORRIS
DICKINSON
KANSAS CITY
OLATHE
LAWRENCE
TOPEKA
OSKALOOSA
HOLTON
HIAWATHA
SENECA
MARYSVILLE
WESTMORELAND
ALMA
MANHATTAN
JUNCTION CITY
CLAY CENTER
TROY
ATCHISON
LEAVENWORTH
WASHINGTON
ABILENE
KANSAS
RIVER
REPUBLICAN
Soldier
Creek
Delaware
River

Preliminary Study of Insoluble Residues of Kansas Pennsylvanian Rocks

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Insoluble residues as here defined are the substances that remain on the complete digestion of calcareous rocks in commercial hydrochloric acid. Ordinarily 25 to 30 grams of the broken rock are placed in a beaker, covered with hydrochloric acid diluted to half strength and allowed to stand until all of the soluble material has been digested completely. Silica in one form or another, principally as fossil debris or in granular form, constitutes by far the greater part of most insoluble residues. The common types thus observed are the following: (1) silicified fossils and fossil debris, (2) chert, (3) granular silica, (4) silicified oolites and colloids, (5) sand, (6) ferruginous material, (7) mineral crystals such as those of quartz, pyrite, sphalerite, limonite, (8) casts or impressions of dolomite crystals (dolocasts) and miscellaneous objects as siliceous flakes, grains of glauconite, fragments of hematite, carbonaceous material, shale particles, clay, silt, mica flakes, etc.

Although studies of insoluble residues at the present time are used primarily for purposes of correlation, such studies have a wide application in strictly scientific investigations (*1*). Insoluble residues show the character of the rocks and the different constituents, and thus indicate the character of the sediments that were deposited, the possible source of the material and the conditions under which they were laid down. In the process of preparation the presence of organic matter can be detected easily. According to McQueen (*2*) from a study of insoluble residues "erosion surfaces and unconformities have been recognized. Areas in which sedimentation in basins has been a dominant process have been determined. Important overlaps also have been recognized. The residues also yield data regarding other processes affecting calcareous rocks. When and how did dolomitization or silicification take place?"

The residues included in this study were obtained from seventeen limestones cropping out in Douglas county, Kansas. The various limestones analyzed are members of limestone formations included between the Stanton limestone of the Lansing group, Missouri series, and the Hartford limestone member of the Topeka limestone of the Shawnee group, Virgil series. All of the rocks are of Pennsylvanian age. The stratigraphic relationship of these limestones is graphically represented by figure 1.

The primary purpose of this preliminary investigation was to determine whether or not the various limestones could be differentiated on the basis of their insoluble residues.

DESCRIPTION OF RESIDUES

Practically all of the residues studied contain varying amounts of brown, spongy silica and pitted, soft aggregates of silt. This material not only varies in color from one member to another, but very definite differences in color have been noted among the several formations. In some members the spongy

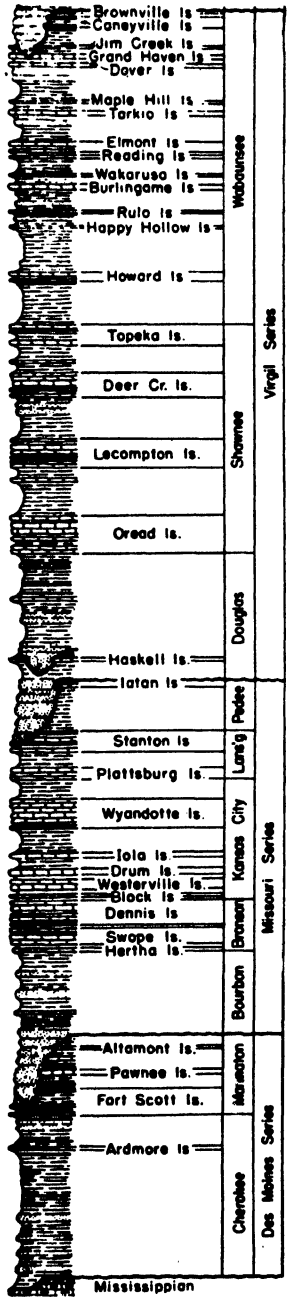

FIG. 1. Geologic column showing stratigraphic relationship of limestones studied.

silica and the aggregates of silt are fine, whereas in others the material is very large and coarse. The amount of this material also varies with the limestone studied. Quartz grains are present in almost every residue. Their shape, size, transparency, and amount constitutes the diagnostic characteristics. Silicified organic remains occur in varying amounts and constitute an important characteristic in most samples studied. Pyrite is very common, and unless forming the greater portion of the insoluble material, is not considered a diagnostic character. Glauconite also appears in many residues, but likewise is not considered diagnostic except if found in large quantities.

STANTON LIMESTONE FORMATION

The Stanton limestone formation consists of five members of which three are limestone, namely: Captain Creek, Olathe, and Little Kaw limestones.

Captain Creek Limestone Member. Residues from this member contain a large percentage of brown, spongy silica, soft, pitted aggregates of silt, aggregates of cubic limonite which is pseudomorphic after pyrite and numerous large fragments of chalcedony (jasper). Organic remains and quartz grains are present in minor amounts.

Olathe Limestone Member. Fragments of gray sandy shale constitute the greater volume of all of the residues from the Olathe limestone member. This shaly material is fairly persistent throughout the member except in the very basal portion where a predominence of pitted, soft aggregates of silt occur. A distinctive feature of the organic material present is a small, white, spherical form which appears to be a species of foraminifera. Although it composes only a very small percentage of the residues its occurrence with the quantities of gray sandy shale serves to distinguish this member (Pl. I, fig. 1.)

Little Kaw Limestone Member. Quartz grains compose approximately three fourths of the residue from this member. The quartz grains vary in size. Many of them are very small and sharply angular, whereas the larger ones are angular to subangular or fairly well rounded. Many of the latter are frosted. The remainder of the residue consists of gray, sandy shale, large fragments of brown, spongy silica and mica flakes. The mica flakes are large, many of them measuring as much as 0.6 mm. They serve to distinguish this residue from other sandy residues within the area studied. (Pl. 1, fig. 2.)

STRANGER LIMESTONE FORMATION

Haskell Limestone Member. The residues from this member consist of quartz grains, dark-brown, spongy silica, pitted, soft aggregates of silt, fragments of gray sandy shale and varying amounts of organic material, such as encrusting foraminifera. The quartz grains which constitute the greater percentage of the residue are fairly uniform in size and are angular. This residue may be distinguished from the Little Kaw residue by (1) the uniform size of the quartz grains, (2) the relatively larger amount of brown, spongy silica and soft, pitted aggregates of silt, and (3) the absence of large quantities of micaceous material. (Pl. I, fig. 3.)

LAWRENCE SHALE FORMATION

Conglomerate. A conglomeratic limestone occurs within the Lawrence shale. The exact stratigraphic position of this member is at present unknown. The outstanding characteristic of the conglomerate residue is the very large amount of brown, pitted aggregates of silt and brown, spongy silica. This material replaces a great variety of organisms. The recognizable forms replaced are fusulinids, crinoid stems, and fragments of brachiopod shells. A characteristic difference of the silt aggregates and spongy silica in this residue is the variety and perfection of molds left by the dissolving of the organism. In no other residue is this character so prominent. The large size of the silt aggregates and the fragments of brown spongy silica is also characteristic. A few large fragments of white, sandy shale occur in every residue. This material is fine in texture, quite dense and much harder than shale fragments in other residues. A number of quartz grains of about .08 mm. in diameter are present. These form only a very small percentage of the entire residue. Some flakes of mica are also present.

OREAD LIMESTONE FORMATION

The Oread limestone formation consists of seven members, four of which are limestone. These, named in ascending order, are the Toronto, Leavenworth, Plattsmouth and Kereford limestones. The Kereford limestone was not observed in the field work for this study.

Toronto Limestone Member. Pitted aggregates of silt and spongy silica comprise by far the greater amount of material in the Toronto residue. This material, almost without exception, is yellowish-brown in color. The fragments vary in size from fine powder to 3 mm. Its chief diagnostic value lies in its association with large white aggregates of siliceous material. Irregularly spaced protuberances give these aggregates somewhat the appearance of a flower bud. Very fine sand grains all under 0.1 mm. in size are common. Mica flakes are persent in minor quantities. Some of the samples contain occasional grains of glauconite. However, the amount is not sufficient to be called diagnostic when compared with the quantity observed in the Hartford limestone of the Topeka limestone formation described elsewhere in this report. (Pl. I, fig. 4.)

Leavenworth Limestone Member. Residues from this member consist predominantly of pyrite and grayish-white silica. Pyrite usually constitutes more than one half of the entire residue. It replaces the shells and spines of a number of organisms. The gray silica also consists of organic remains.

Plattsmouth Limestone Member. The residues from this member contain chert in varying amounts. The chert is bluish-gray in color and contains fragments of silicified organisms. Large fragments of white porous chert are also common. Large white aggregates of silica similar to those found in the Toronto member are also common. In most samples the organic material present constitutes the greater part of the residue. This material consists of broken shells of brachiopods and perhaps mollusks, brachiopod spines, and various kinds of sponge spicules. (Pl. II, fig. 1.)

KANWAKA SHALE FORMATION

Clay Creek Limestone Member. The Clay Creek limestone occurs within the Kanwaka shale. The residue is characterized by fine gray shale which forms molds or organic material. Minor amounts of unrecognizable organic remains are present. A considerable amount of very fine pyrite crystals is disseminated throughout the shale.

LECOMPTON LIMESTONE FORMATION

The Lecompton limestone formation consists of seven mumbers, four of which are limestones, namely (1) Spring Branch, (2) Big Springs, (3) Beil, and (4) Avoca limestones.

Spring Branch Member. Residues from the very base of this member are composed almost entirely of pyrite. The other residues are characteristically yellow-brown in color and consist of spongy silica, pitted aggregates of silt and white silicified organic material. The diagnostic residue of this member lies within a zone which does not extend to the very base nor to the top of the member. Such material consists of fragments of internal molds of fusulinids. Some of these remains are of white silica, others are of brown, spongy silica and still others are of soft, pitted silt. (Pl. II, fig. 2.)

Big Springs Member. A large portion of this residue is made up of angular fragments of buff-gray chert which contain silicified ostracodes. The remainder of the residue is dark brown in color. This color is due to the presence of a large percentage of cubic limonite which is pseudomorphic after pyrite. The most striking feature is the considerable number of ostracodes, some of which are replaced by silica and others by limonite. (Pl. II, fig. 3.)

Beil Limestone Member. The residue of the Beil limestone contains organic remains, soft aggregates of pitted silt, yellowish-brown, spongy silica, and fine quartz grains. Usually the organic material equals or exceeds the yellow, pitted, soft aggregates of silt and the spongy silica. The entire residue has a "mealy" appearance due to the relatively small size of the particles and the nearly equal parts of the organic material, silt and spongy silica. Occasional white spherical forms, comparable to those described in the Olathe limestone, are present in some residues. However, the absence of gray shale in the Beil residue serves to distinquish this member from the Olathe limestone member. Fusulinid remains similar to those found in the Spring Branch member are also present. The "mealy" texture of the Beil residue serves to distinguish it from the coarser residue of the Spring Branch member.

Avoca Limestone Member. Residues from this member consist of pyrite together with varying amounts of white silicified organic remains and brown, spongy silica. The pyrite is especially conspicuous because it replaces organic material consisting of bryozoans of several species, fusulinids, brachiopod shells and spines.

DEER CREEK LIMESTONE FORMATION

The Deer Creek limestone contains five members of which three are limestone, namely (1) Ozawkie, (2) Rock Bluff and (3) Ervine Creek.

Ozawkie Limestone Member. The residue from this member consists of yellowish-brown spongy silica, pitted aggregates of silt, silicified organic re-

mains, limonite pseudomorphic after pyrite, and occasional large fragments of chocolate-colored limonite of concretionary origin. The distinguishing characteristic of this residue is a coiled foraminifera which belongs to the family Ammodiscidae. Two or three species are present. (Pl. II, fig. 4.)

Rock Bluff Member. The Rock Bluff residue is composed largely of brown, spongy silica and pitted aggregates of brown silt. Some of the silt aggregates measure as much as 3 mm. Pyrite is also present in considerable amounts. Most of it is in the form of crystal aggregates; occasionally it occurs as a replacement of tubular organic forms. Organic material is very rare in the residue. That which does occur is confined almost exclusively to small, highly contorted tubular forms of fragile silica. The scarcity of organic material as compared with the other residues serves to differentiate this horizon from the others.

Ervine Creek Member. From the specimens studied, the Ervine Creek residue can be distinguished from the Rock Bluff residue only by the absence of pyrite which characterizes the latter limestone member. In other respects the two residues are very similar.

TOPEKA LIMESTONE FORMATION

The Topeka limestone contains five members of which only the lowermost or Hartford limestone member is included in this study.

Hartford Limestone Member. The residue from this member is characterized by silicified fragments of macrofossils, quartz grains, glauconite and yellowish-brown, spongy silica. Although occasional grains of glauconite occur at various horizons, the amount is not sufficient to be diagnostic.

CONCLUSIONS

Studies carried on thus far with the Pennsylvanian rocks of eastern Kansas indicate that the insoluble residues are diagnostic not only of formations, but also of members within the formations. Residues from different formations may show similarities. However, each formation thus far studied is characterized by certain insoluble residues which are diagnostic for that particular formation. This is especially true when the residues of each member of the formation are analyzed in proper sequence. (See chart showing diagnostic insoluble residues of Pennsylvanian rocks studied.) The residues were also compared with other residues obtained from limstones of the same and younger formations collected by the senior author in Jefferson, Atchison, and Doniphan counties. Since the residues from the limestones of Douglas county are similar to those of limestones of the same age from the counties lying to the north, the use of insoluble residues in the identification of rock formations has more than local application

Chart Showing Diagnostic Insoluble Residues of Pennsylvanian Rocks Studied

FORMATION.	Member.	Characteristic residue.
Topeka limestone	Hartford.........	Organic remains, quartz grains, glauconite.
Deer creek limestone	Ervine Creek.....	Resembles Rock Bluff residue, but lacks pyrite.
	Rock Bluff.......	Pyrite, brown spongy silica, and pitted aggregates of silt. Scarcity of organic material.
	Ozawkie..........	Yellowish-brown spongy silica, pitted aggregates of silt. Organic remains. Coiled foraminifera of family *Ammodiscidae*.
Lecompton limestone	Avoca............	Fossils replaced by pyrite. Organic remains composed of gray silica. Brown spongy silica, pitted aggregates of silt.
	Beil..............	"Mealy" texture, fine quartz grains, organic material, yellowish-brown spongy silica and pitted aggregates of silt.
	Big Springs.......	Buff-gray chert containing ostracodes. Silicified ostracodes, cubic limonite, pseudomorphic after pyrite.
	Spring Branch....	Dominantly fusulinid remains, some of white silica, others of brown, spongy silica and pitted silt.
Kanwaka shale	Clay Creek.......	Fine gray shale. Fine pyrite crystals.
Oread limestone	Plattsmouth......	Bluish-gray chert, white porous chert, large white siliceous aggregates, organic material, brown, spongy silica and pitted aggregates of silt.
	Leavenworth......	Pyrite crystals and pyrite replacement of organisms; grayish-white silica.
	Toronto..........	Yellowish-brown spongy silica and pitted aggregates of silt; large white aggregates of silica; fine quartz grains.
Lawrence shale	Conglomerate.....	Coarse fragments of brown, spongy silica and pitted aggregates of silt, forming molds of organisms.
Stranger limestone	Haskell..........	Quartz grains (well sorted); dark brown spongy silica; pitted aggregates of silt. Organic remains.
Stanton limestone	Little Kaw.......	Quartz grains, gray sandy shale; brown, spongy silica, pitted aggregates of silt, large mica flakes.
	Olathe...........	Gray sandy shale; brown, spongy silica, pitted aggregates of silt, white spherical Foraminifera.
Stanton limestone	Captain Creek....	Brown, spongy silica; organic remains. Jasper (chalcedony), quartz grains.

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PLATE I

FIG. 1. Olathe limestone. $\times$ 10.
FIG. 2. Little Kaw limestone. $\times$ 15.
FIG. 3. Haskell limestone. $\times$ 10.
FIG. 4. Toronto limestone. $\times$ 10.

PLATE I

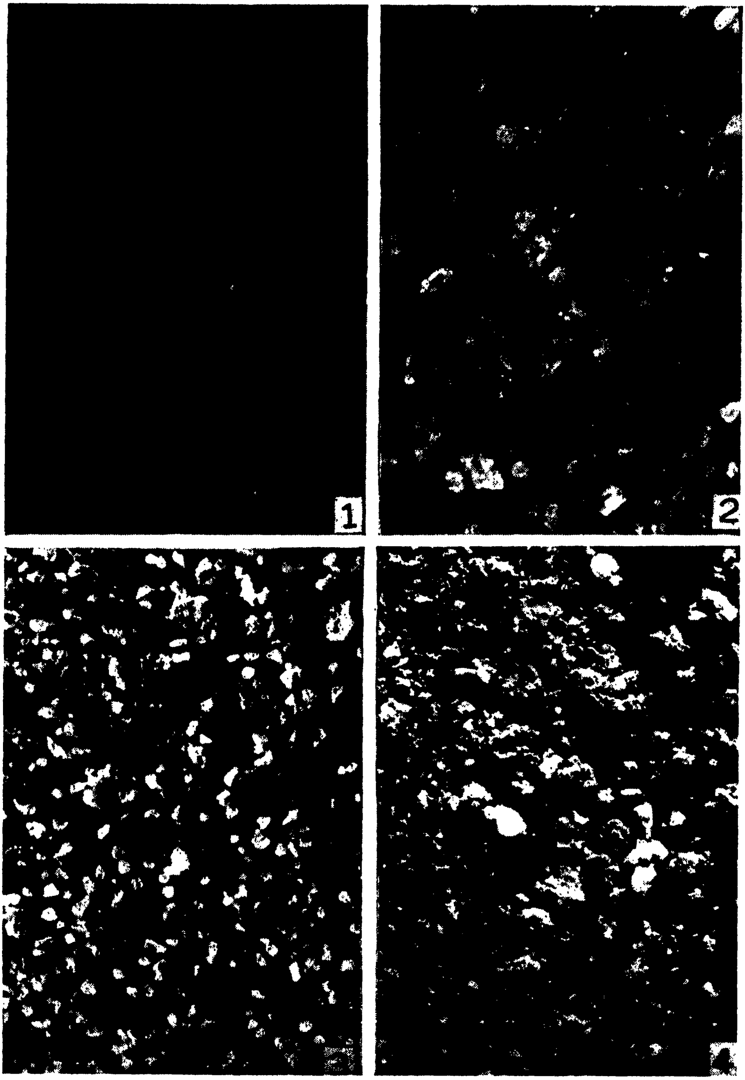
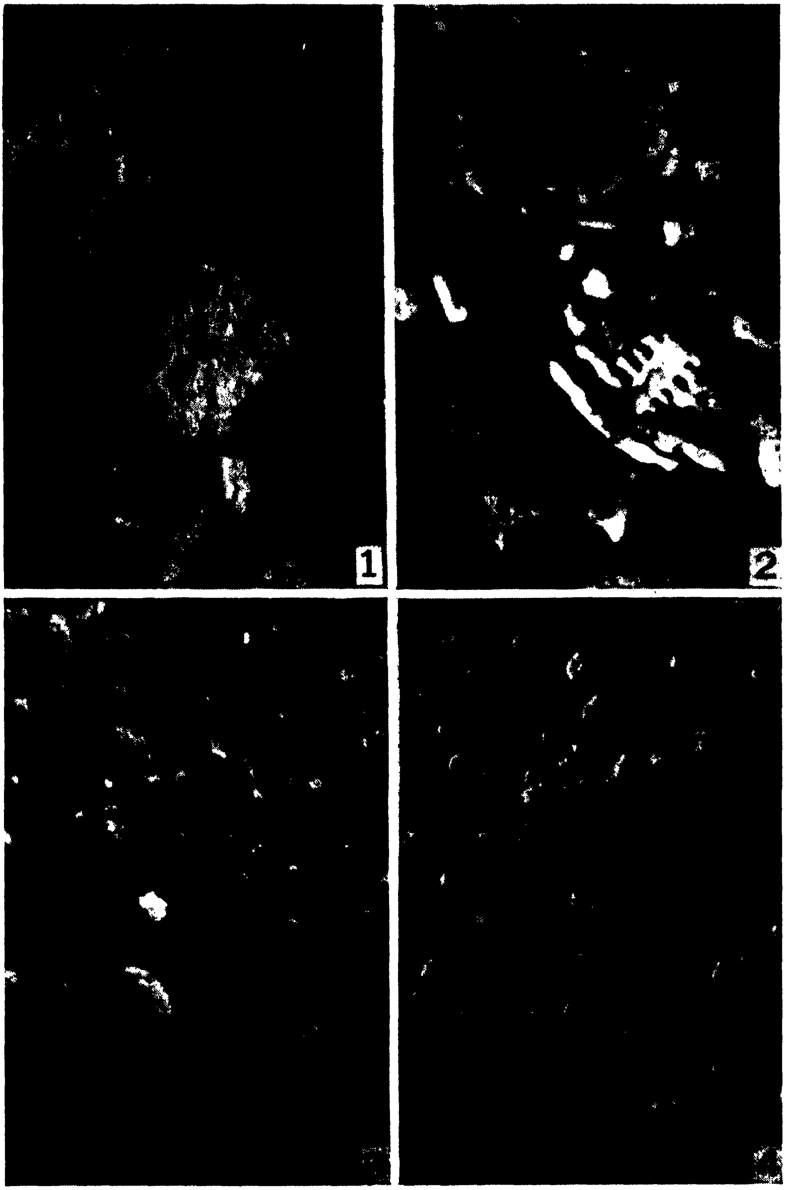


PLATE II

FIG. 1. Plattsmouth limestone. $\times$ 10.
FIG. 2. Spring Branch limestone. $\times$ 7.
FIG. 3. Big Springs limestone. $\times$ 10.
FIG. 4. Ozawkie limestone. $\times$ 10.

PLATE II



Preliminary Notes on Pleistocene Gravels in Southwestern Kansas

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INTRODUCTION

The fluviatile Pleistocene of the Arkansas valley in southwestern Kansas has thus far remained practically unnoticed, despite recent progress in the study of Quaternary formations elsewhere in Kansas, and in Nebraska. In the latter state, a Pleistocene history of considerable complexity has been outlined by Lugn (*16*). In Wallace county, northwestern Kansas, Pleistocene gravels and loess have been described by Elias (*11*). In south-central Kansas, the McPherson formation, of Pleistocene age, has long been known (*2*). Along the Smoky Hill and Saline rivers, in Russell county, Pleistocene terrace deposits were recognized by Rubey and Bass (*8, 9*). Along the Medicine Lodge drainage system, a Pleistocene alluvial deposit, the Gerlane formation, has been studied by Knight (*14*). In the drainage area of the Arkansas river, however, Pleistocene stream deposits have been described only along Pawnee river, a tributary stream (*12*), and have been given merest mention along the river itself (*7, 13*).

Reconaissance field studies during the summer of 1936 showed that Pleistocene gravels are widely distributed along the Arkansas Valley in southwestern Kansas. In the Great Bend region they occur in a broad belt extending south to the upland rim leading down to the Medicine Lodge drainage system. West of the Great Bend region, the gravels are found in a belt immediately bordering the river valley. At all places they occur above the level of the present floodplain of the river.

The Pleistocene gravels of southwestern Kansas are of both theoretical and practical interest. For the historical geologist they hold the record of stream erosion and deposition, and perhaps also of crustal deformation, in southwestern Kansas during the changing conditions of Quaternary time. To the engineer they are of interest as bearers of underground water, and as sources of gravel for road surfacing and construction work.

Acknowledgments. The field work here reported was conducted as a State Geological Survey of Kansas project, and is published with the permission of the director of the survey. Identification of vertebrate fossils collected during the course of the work was made by Mr. Claude W. Hibbard, of the University Museum at Lawrence, to whom the writer is indebted also for critically reading those portions of this manuscript concerned with paleontology. A Paulin altimeter used in the field work was purchased with a grant from the Graduate Research Fund of the University of Kansas.

DISTINCTION BETWEEN TERTIARY AND QUATERNARY GRAVELS

Quaternary is used here as being synonymous with *post-Ogallala,* the algal limestone described by Elias (*11*) being accepted as the top of the Ogallala formation. The possibility that certain of the gravels described in this paper are post-Ogallala, and yet fall within latest Tertiary, is admitted. The term *gravels* is used here to designate fluviatile deposits in general including sand, silt, and minor amounts of clay associated with the gravels proper.

The distinction between Tertiary and Pleistocene gravels presents some difficulties, and it is undoubtedly for this reason that recognition of the latter has been delayed. Paleontologic evidence is most decisive, but unfortunately, is meager in most parts of the area. Stratigraphic and topographic position, and lithology, are more generally applicable, but must be checked by one another and by the evidence of fossils wherever possible, and even then are not always unequivocal. In the following discussion these various criteria are considered in some detail. Their value in areas other that the Arkansas Valley is yet to be tested.

1. *Vertebrate fossils.* Identifiable fossils of forms known definitely to be Pleistocene constitute the best proof of post-Tertiary age. Most helpful are remains of the horse, camel, elephant, bison, and of certain rodents. Complete or nearly complete skeletons are naturally desirable, but skulls, jaws, teeth, and limb joints are in some instances satisfactory for generic determinations which are at least strongly suggestive as to age. Generally, however, even fragments are uncommon and good specimens are rare indeed.

The mode of fossilization itself may be suggestive as to age. Fossils preserved by silicification are commonly Tertiary, and are readily distinguished by their greater density, superior hardness, and flinty appearance. Fossils showing preservation or the lack of it as a result of other processes may be either Tertiary or Pleistocene.

The presence of fragmentary Tertiary fossils need not exclude the possibility of Pleistocene age of particular deposits. Such fragments, particularly those of the silicified type, may simply have been eroded from the older formation and redeposited in the younger. The presence of complete or partial skeletons or bone assemblages, however, would minimize the possibility of reworking.

2. *Presence of pebbles eroded from the Tertiary.* In places the Quaternary gravels contain water-worn pebbles of typical Ogallala material, particularly of the calcareous phases. Where present, these provide good evidence of post-Ogallala age, such occurrences not having been found within the Ogallala.

3. *Abrupt lateral and vertical changes in lithology.* Where relatively loose and clean sand and gravel is underlain and/or flanked by material markedly different in composition and in degree of induration, an unconformity is suggested. This is particularly true where one phase is notably calcareous and the other shows beds which are noncalcareous, although perhaps texturally similar. In some places the loose, fresh, Quaternary gravels may be seen to occur as definite channel deposits on the calcareous Ogallala.

4. *Composition of the gravels.* The contrasted physical and climatic conditions of Tertiary and Quaternary time are reflected in the character of their stream deposits. Degree of sorting, particle size, porosity, induration, lime content and color are all significant.

The Quaternary gravels, in general, are cleaner, more porous, less indurated, better sorted, and coarser than the Tertiary. The Ogallala gravels, in contrast, tend to have a "dirty" appearance, due to admixed silt and clay, are more compact and better consolidated, contain relatively small pebbles, and carry a greater proportion of interbedded fine material. Maximum pebble size in the younger gravels is commonly up to double that in the older deposits of the same general area.

Calcareous material is abundant in the Ogallala, occurring as nodules, as cement, and as well-defined beds. The latter occur mainly toward the top of the formation. In form, the lime is generally amorphous, but in some places is megascopically crystalline. In the gravel beds, it produces an appearance like that of concrete. In the Quaternary sand and gravel, however, lime is generally absent, except as a superficial mantle or crust of caliche.

The color of typical Tertiary and Quaternary gravels is distinctively different. In the Ogallala, reddish or brownish buff is prevalent, varied in places with bands of light gray due to abundant lime. In the Pleistocene deposits, the characteristic color is a neutral gray, mottled here and there with irregular streaks and stains of sooty-black and rust-colored iron oxides, particularly in the coarser layers. The black stain, in particular, appears to be typical of the Pleistocene material, although not unknown in the Tertiary. A similar stain was observed by the writer to be common in certain of the Pleistocene gravels of eastern Massachusetts.

In the Quaternary gravels, rounded masses of plastic clay, up to a foot or more in diameter, are common. These have not been found in the Tertiary. Although conclusive evidence is yet lacking, it is believed that these clay balls were probably derived from Quaternary clay beds.

A possible additional criterion for distinguishing Tertiary and Quaternary gravels might lie in the petrography of the pebbles. Conceivably, the Quaternary gravels might contain pebbles derived from post-Tertiary volcanics, such as those of southeastern Colorado, or from older crystalline rocks which had not yet been uncovered by erosion at the close of Ogallala time. Much additional study is necessary, however, to determine the feasibility of this method of approach.

In applying the above lithologic criteria, good exposures are essential. Gravel pits are best, certain steep stream bluffs next, and road cuts occasionally satisfactory. Generally, no very definite conclusions can be reached unless the material is well exposed to a depth of at least five feet.

5. *Topographic position.* Where unconsolidated gravels form a distinct topographic bench or terrace well below the upland (Ogallala) level of the vicinity, and maintaining a consistent height above present stream level, post-Tertiary erosion and deposition is strongly suggested.

OCCURRENCE OF THE GRAVELS

Localities at which gravels of probable Pleistocene age were studied in good exposures, mainly gravel pits, are indicated by dots on the accompanying map, figure 1. Although all of these deposits are believed to be post-Tertiary, further subdivision is not yet practicable in most places, and it is probable that the deposits noted range widely in age within the Pleistocene.

Arkansas Valley west of the Great Bend. West of the Great Bend, the Pleistocene gravels occur as terrace deposits bordering the present floodplain of the river. The height of the terrace above river level averages fifteen to twenty feet, and appears to rise slightly to the west. The thickness of the gravel ranges from less than ten feet to more than twenty feet, the base being concealed in many places. Between good exposures, the presence of the gravel is suggested at some places by the topographic terrace, but in many other places even this is obscured by erosion or masked by sand dunes.

The breadth of the gravel belt is difficult to determine. Most of the artificial exposures are located at the very edge of the terrace. The inner boundary of the terrace itself is concealed by sand hills. South of Garden City, however, one gravel pit is located about 1.5 miles south of the terrace edge, indicating that the gravels there have that minimum width. Furthermore, the intimate association of dune sand with the Pleistocene gravels, where these are identifiable, suggests the latter as the source of the former, and further suggests that the distribution of dune sand may give a very rough picture of the distribution of the gravels.

The origin of the gravels described above presents no problem. Obviously, they were deposited by the Arkansas river at some time during the Pleistocene when it was flowing at a higher level than at present, but below the level of upper Ogallala deposition.

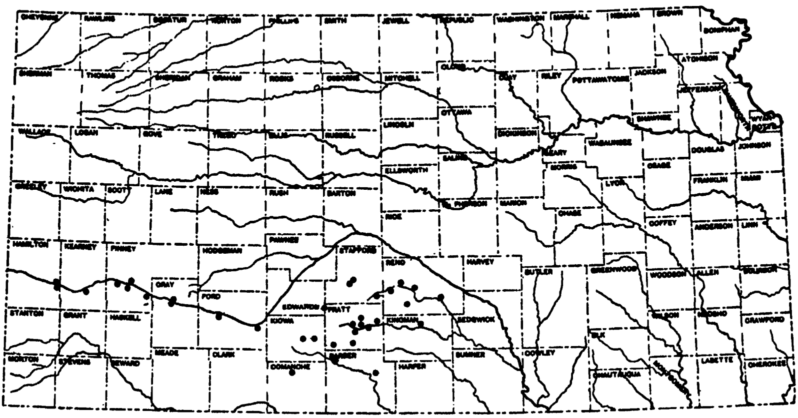

FIG. 1. Map showing localities in southwestern Kansas where post-Ogallala gravels were found to be well exposed for study.

The Great Bend area. Within the Great Bend area, the Pleistocene gravels are widely distributed, and occur at great distances from the present course of the Arkansas river. The exposures studied are nearly all located along streams—Rattlesnake creek, the Ninnescah river and its several branches and tributaries, and certain tributaries to the Medicine Lodge river, along their uppermost stretches. These exposures range vertically from just above present stream level to heights of up to forty feet or more above modern stream level, the greatest vertical range—and the most numerous exposures—being found in Pratt county, particularly near the town of Pratt, where local relief is relatively great. The higher-level gravels are all similar in character, closely resemble the terrace deposits along the Arkansas river farther west, and show no apparent genetic relation to the modern streams along which they occur, many of these being feeble indeed. The association between gravel pits and stream courses, in fact, appears to be mainly one of ease in discovery and utilization of the gravels. The distribution of existing exposures suggests that the gravels actually may occur as a widespread mantle deposit, covering at least a large portion of the Great Bend area.

Along the Arkansas river in the Great Bend area, no distinct topographic terrace comparable to that bordering the river farther west is observed. Along the larger tributary streams—Walnut creek, Pawnee river, and Mulberry creek—however, an apparently persistent terrace ranging from about fifteen to thirty feet above stream level testifies to a former higher level of the main stream to which the tributaries were graded.

The origin of the gravel deposits in the Great Bend region raises many questions. At least in part, the gravels were certainly deposited by a through-going river, presumably the ancestral Arkansas. Did this river swing across the entire area, leaving in its wake a continuous gravel mantle, or did it occupy a succession of broad, shallow channels, here discontinuous, but converging eastward and westward, each a step toward the river's present course? Until more definite information as to the presence or absence of gravels between known occurrences, particularly in the higher parts of the area, is available, this question cannot be satisfactorily answered. If a once-continuous gravel capping does cover the undissected portions of the Great Bend upland, the lower gravels may well have been derived from the reworking of this deposit by ancient tributary streams. In any event, the cause for the river's northward migration to its present course remains a mystery. Structural control in different forms has been suggested by Haworth (*1*) and Darton (*6*), and stream piracy under the influence of local crustal warping has been postulated by Courtier (*13*). All of these proposed explanations are largely conjectural, and indeed no final solution can be made until much additional specific information as to the distribution and character of stream deposits is available.

Channel fill in the Arkansas Valley. Beneath the floodplain of the Arkansas river throughout its course in Kansas there are alluvial deposits varying in thickness from a few tens of feet to more than a hundred feet (*5*). Water wells along the river valley are supplied mainly from this fill. The upper part of this fill is undoubtedly recent, and the basal part, in places, may possibly date back to the Tertiary. Much of the fill, however, may well be of Pleistocene age, either contemporaneous with or younger than the terrace deposits.

Medicine Lodge River. At scattered localities along the Medicine Lodge river in Barber county, terrace gravels are found at elevations of about forty-five and ninety feet above present stream level. These gravels are older than the Gerlane formation, described by Knight (*14*), which occurs at a lower level. They are composed of material derived partly from erosion of the Pleistocene gravels and underlying Ogallala to the north, and partly from Permian and Cretaceous sedimentaries. They appear to be distinctly younger than the Quaternary gravels in the southern part of the Great Bend area.

AGE AND CORRELATION

A list of the vertebrate fossils found during the summer of 1936 is presented in Table I. These fossils indicate a Pleistocene age for the deposits in which they were found, and for other similar deposits inferentially, but are too few and too fragmentary to denote stages within the Pleistocene. Physiographic and stratigraphic data, however, suggest that the different deposits may range widely in age within the Pleistocene.

In the absence of more adequate paleontological data, correlations can be made only on the basis of comparative topographic occurrence, and can be

only tentative. To the east, it seems probable that the McPherson formation (*2*), or some part of it, may be equivalent to the gravels here described. To the west, in Colorado, there are terrace deposits at various levels above modern stream grade, which are undoubtedly related to the gravels in Kansas. West of the Royal Gorge, Powers (*15*) has described a series of 7 terraces ranging from 20 to 390 feet above river level, the lower 5 being definitely dated as of Glacial age, and the upper 2 being possibly post-Pliocene. Farther east, it appears either that certain of these terraces converge, or that they have escaped recognition, only 2 post-Ogallala terraces being reported from the Nepesta quadrangle (*4*), these being graded to former levels of the river approximately 50 and 100 feet above the present level, respectively. Possibly the lower of these terraces converges with modern stream grade to the east, and is represented in Kansas by the gravels described in this paper. Or possibly the two terraces converge with one another as well as with modern river level, and are both represented in the Kansas gravels. Much additional study in the intervening areas is certainly necessary to establish a final and definitive correlation. Finally, possible correlations between the gravels of the Arkansas valley and the terrace deposits of the Smoky Hill river (*8, 9, 11*) may be suggested, but in the absence of specific paleontologic evidence are entirely speculative.

Whatever conclusions may finally be reached as to areal correlations, it cannot be doubted that the erosional and depositional work of the Arkansas river in Kansas during Quaternary time was greatly influenced by Pleistocene climatic changes and by intermittent uplift in the Rocky Mountain region. In addition, local crustal warping may have been an important modifying factor. Future study may lead to a clearer recogntion of the part played by each of these factors.

ECONOMIC IMPORTANCE OF THE GRAVELS

The Quaternary deposits of southwestern Kansas supply a large proportion of the gravel used for road surfacing and construction purposes. More detailed knowledge of the origin and occurrence of the gravels may conceivably lead to the development of new gravel pits and reduce the distance of haulage in some parts of the region.

The importance of the gravels as aquifers may be considerable, but is yet somewhat uncertain. Additional information on the thickness and distribution of the gravels is necessary to answer this question. Such information, however, may be difficult to obtain, for the criteria used to distinguish Tertiary and Quaternary gravels at the surface are less applicable to well records.

Quaternary sand and gravel, and other deposits, constitute the parent material for soils over wide areas. Soil studies might well be facilitated by attention to the character and occurrence of the gravels, and soil studies, in turn, might contribute much information of value to the geologist.

OTHER PLEISTOCENE FORMATIONS

Pleistocene formations other than fluviatile sand and gravel include dune sand, volcanic ash, loess, and lacustrine silt and clay.

Dune sand occurs on the upland north of Hutchinson, over much of the Great Bend area, and in a belt of varying width bordering the south side of the Arkansas river west of the Great Bend. A few smaller localities lie north

TABLE I.—List of vertebrate fossils collected in southwestern Kansas during the summer of 1936 (identifications by Claude W. Hibbard).

QUATERNARY FORMS:

Comanche County:

Gravel pit 1 mile north of Coldwater, NW¼ sec. 6, T. 32 S., R. 18 W., vertebra, *Equus* sp.

Finney County:

Small gravel pit about 2 miles northeast of Garden City, N. cent. sec. 9, T. 24 S., R. 32 W., jaw, *Citellus elegans* Kennicott, at depth of 4 feet (*17*).

Gravel pit south of Pierceville, E. cent, sec. 23, T. 25 S., R. 31 W., toe bone, *Bison bison,* (ranges to Recent).

Ford County:

Abandoned gravel pit south of Dodge City, NW¼ sec. 2, T. 27 S., R. 25 W., tooth fragment, *Equus* sp. (Pleistocene).

Main gravel pit south of Dodge City, N. cent. sec. 2, front humerus, Bison sp. (Pleistocene).

Kiowa County:

Gravel pit south of Brenham, SW¼ sec. 3, T. 29 S., R. 17 W., uncut tooth, *Equus* sp. (Pleistocene).

Meade County:

Volcanic ash pit just east of Fowler, S. cent, sec. 33, T. 30 S., R. 26 W., bird, being studied by Dr. A. Wetmore, U. S. National Museum.

Volcanic ash pit north of Meade, sec. 2, T. 31 S., R. 28 W., teeth collected by Mr. Millard Moler from beds just under volcanic ash, *Equus* ep. (upper Pliocene or early Pleistocene?).

Pratt County:

Gravel pit on north side of Highway U. S. 54, just west of Pratt, part of pelvis of *Elephas* or *Mastadon* (Pleistocene).

Ditches in town of Pratt, just northwest of Power Plant, at depth of about 5 feet in loess-like silt, jaw and teeth of *Bison bison* (late Pleistocene or Recent).

Reno County:

Gravel pit about 3 miles southeast of Zenith, NW¼ sec. 5, T. 25 S., R. 10 W., tooth, *Equus* sp. (lower Pleistocene?).

PLIOCENE FORMS, APPARENTLY REWORKED:

Pratt County:

Small pit about 2 miles west of Pratt, N. cent. sec. 31, T. 27 S., R. 13 W., silicified leg bone of large Camel (middle Pliocene?).

Pit in western part of Pratt, cent. sec. 33, T. 27 S., R. 13 W., silicified tooth, *Equus* sp.

South of Highway U. S. 54, 5.5 miles east of Pratt, NW¼ sec. 4, T. 28 S., R. 12 W., 4.5 feet below surface on roadside bluff, silicified leg bone, *Equus* sp.

North of Highway U. S. 54, 6 miles east of Pratt, SE¼ sec. 33, T. 27 S., R. 12 W., at surface on stream bluff, silicified tooth, *Equus* sp.

of the river, and other localities occur in the drainage basin of the Cimarron river. In the area northeast and north of Hutchinson there are at least two ages of dune sand. The older sand is reddish-brown in color and is semiconsolidated. Its stoss or windward bedding is remarkably regular in strike, and has a northerly dip of the order of 10°, indicating deposition by strong, constant winds from the north. The sand was probably derived from the McPherson formation along the valley of the Little Arkansas river. The younger dune sand is light buff in color, is unconsolidated, and shows variable bedding and cross-bedding. It is separated from the older dune sand by a well-developed, dark-colored soil zone, although in places this was eroded away prior to deposition of the younger sand, which, in places, is still in motion.

In the Great Bend area, road cuts between Kinsley and Greensburg and between Great Bend and Pratt show that the sand hills farthest from the river have stoss bedding similar to that in the Hutchinson area, suggesting deposition under a similar wind system. Here, also, there are indications of considerable weathering, and the sand is somewhat consolidated, so that the bedding is etched in relief by modern weathering and wind action. These dunes, or sand hills, were probably formed well back in Pleistocene time, and then were modified by shifting winds at later times, on down to the present. In the belt bordering the river, however, the dune sand is clean and loose, and shows but the slightest weathering, if any. Here the dunes appear to be relatively young, and probably are largely of recent age. Both in and west of the Great Bend region, dune sand overlies the Pleistocene gravels. In fact, the two formations appear to be roughly coextensive, suggesting that the dune sand was probably derived, at least in part, from ancient alluvial flats of the Arkansas river.

The occurrence of volcanic ash in western Kansas has been described by Dr. K. K. Landes *(10)*. Its relation to the Pleistocene fluviatile deposits has not been determined.

Loess has been described from western Kansas by many writers *(3, 7, 11)*. Along the Arkansas River valley it was found in greatest thickness and purity in southern Ford county and in parts of western Kiowa county. Elsewhere, in diluted form and with lesser thickness, it may form a widespread surficial mantle deposit. In the large pit just east of Fowler in Meade county, loess overlies volcanic ash with apparent conformity. The loess is capped by a well-developed soil zone, and this is overlain by dune sand on which a second soil zone is prominent. Whether more than one age of loess is present in southwestern Kansas has not yet been determined.

Lacustrine silts and clays containing abundant gastropod and pelecypod faunas occur in the town of Pratt, along the headwaters of Bluff creek in Clark county, and probably elsewhere. The invertebrates from these deposits are being studied by Prof. Norman Newell and Mr. Raymond Keroher. Until these and other studies are completed, the correlation and relative age of these deposits remains in doubt.

FUTURE INVESTIGATIONS

Much remains to be done before the Pleistocene of southwestern Kansas is as well known as that of Nebraska. Continued field studies over wide areas will be necessary to determine more adequately the distribution of the various

Pleistocene deposits, their relations to one another, and their relations to climatic changes and to tectonic movements. Particularly helpful would be the finding of more adequate vertebrate faunas at many different localities. Detailed soil studies, too, might provide significant information on surficial materials. Correlation between the work of geologist, paleontologist, soil scientist, and, perhaps, even archeologist will contribute to a final definitive outline of Pleistocene history.

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The Nutritive Value and Cost of Food Consumed by Men and Women in a College Residence Hall

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A weighed inventory dietary study covering a period of two weeks was made at McPherson College, McPherson, Kan., in November, 1935. Such a study was desired to determine any effect on the diet of a low food expenditure made necessary by a decrease in the income of the college.

The meals of the students of McPherson College who live in the dormitories are served in a common dining hall. Two women cooks, untrained in nutrition or dietetics, plan and prepare these meals, which are served in family style by two student waitresses.

During the period of investigation 109 persons were fed. Of this number, 101 were students, 55 men and 46 women, with faculty members and hired help making up the remainder. The mean weight of the group was 61.4 kg. and the mean age 21.6 years. The estimated nutritive needs of the 61.4 kg., or average person, based on accepted standards for a 70 kg. man of moderate activity (*1, 3*), are shown in table 1.

TABLE 1.—Per capita nutritive needs and value of diet

NUTRIENT.	(1, 3).	
	Estimated standard (per 61.4 kg.).	Supplied by die (per 61.4 kg.).t
Energy	2,630.0 cal.	2,760.0 cal.
Protein	61.4 gm.	92.2 gm.
Calcium	0.60 gm.	1.03 gm.
Phosphorus	1.16 gm.	1.71 gm.
Iron	0.015 gm.	0.013 gm.
Vitamin A	3,623.0 units	5,094.0 units
Vitamin C	88.0 units	119.0 units
Vitamin G	658.0 units	740.0 units

The item-by-item method was used for calculating the nutritive content of the diet. The calculations were based on standard tables for food composition. The percentage composition of the edible waste was determined by chemical analysis. From these data the daily per capita consumption was obtained (Table 1). With the exception of iron and vitamin G, the diet apparently furnished a liberal supply of the necessary food constituents and met the nutritional needs of the group in most respects. If the more recently suggested standard for iron be accepted, *i.e.*, 12 mg. per 70 kg. man, as set by Sherman (*2*), the diet may be considered adequate in this respect also. The fact that information concerning quantitative vitamin content of many of the foods used was not available made it possible that the diet was better in vitamin content also than the data indicate.

During this study a total of 3,603 individual meals, supplying over 3 million calories, was served at a cost of 28.6 cents per person per day, or approximately one cent per 100 calories. This indicates that it was possible under the conditions existing in this school to supply a diet nutritionally adequate in most respects for a comparatively small expenditure of money.

Although the food consumed by a group may be satisfactory from the standpoint of nutrition, it may be very unsatisfactory from the aesthetic standpoint in that it lacks variety in color, texture, flavor, and food combinations. This is especially likely to be true when, as was the case in this study, low cost menus are planned for only one meal at a time. This leads to undesirable repetition in the use of foods. For example, apples were served at twenty of the forty-two meals. One day they were served as apple sauce for breakfast, baked apples for lunch, and raw apples for dinner. Foods high in starch, as macaroni and cheese, macaroni and tomatoes, navy beans, rice, breaddressing, and lima beans were generally served with potatoes and as a substitute for a second vegetable. Lack of variety in the use of leftovers made the meals extremely monotonous. As a rule, these leftovers were simply "warmed up" and seldom used as the basis of new dishes.

The advisability of following such practices regarding the use of leftovers, and also the failure on the part of those who plan meals to recognize the need for variety in texture, color, and food combinations, may well be questioned. From observation, it was learned that the appetites of many of the students were affected unfavorably by the repeated appearance of foods constantly prepared in the same way.

The distribution of the money expended for various types of foods and the return in nutrients are shown in table 2. The generally accepted idea that

TABLE 2—Average percentage distribution of cost and nutrients in food served

Type of Food.	Relative cost.	Calories.	Protein.	Calcium.	Phosphorus.	Iron.
Meat and fish	20.8	9.4	29.7	1.7	17.3	22.6
Eggs	2.3	0.7	1.9	0.8	1.4	2.5
Milk, cheese, cream	15.9	16.4	24.0	75.2	36.0	9.9
Butter and other fats	8.4	16.2	0.6	0.2	0.1	0.2
Grain products	16.6	28.3	28.2	5.8	23.2	29.8
Sugar and other sweets	4.7	10.8	0.1	0.1	0.1	0.2
Vegetables	16.3	11.2	12.2	12.7	17.4	28.3
Fruits	10.9	5.0	1.6	2.9	2.5	4.6
Nuts	0.4	0.6	1.2	0.3	1.0	0.6
Food adjuncts	4.0	1.5	0.6	0.3	1.1	1.3

meat is a relatively expensive food appeared to be true in this study. Although it represented the greatest money expenditure (21 percent), protein was the only nutrient in which it ranked first, and then it supplied only two percent more than grain products.

Grain products, the second in money expenditure, ranked first as a source of calories and iron, furnishing approximately one third of both. These foods were second as a source of protein and phosphorus.

Although the money expended for milk and milk products was less than one sixth of the total (in this study, milk was purchased below regular market price), these foods supplied more than seventy-five percent of the calcium in the diet and an amount greater than the estimated requirements for this mineral. They also ranked first as a source of phosphorus, furnishing about twenty-six percent of the total. They ranked second for calories, and third for protein. Although twice as much oleomargarine as butter was served, dairy products supplied forty-five percent of the vitamin A in this dietary. The per capita milk consumption was 1.38 pints. Because milk supplied more than its share of calcium, phosphorus, protein, and calories, its inclusion in liberal amounts is especially recommended for low-cost dietaries.

This study indicates that though low-cost meals planned by untrained persons may be fairly satisfactory from the nutritive standpoint, they are unlikely to meet the necessary aesthetic requirements. It is essential, if proper food attitudes are to be maintained by a group, that the food not only be nutritionally adequate, but that it be prepared and served in an attractive manner in order to meet aesthetic standards.

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Biological Assay of Milk with Lactoflavin as a Standard for Vitamin G[1]

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The lactoflavin content of some composite samples of milk obtained through the Department of Dairy Husbandry at Kansas State College have been studied and are herein reported. The biological method of Bourquin and Sherman (*1*), one that has been used several years for studying vitamin G, was employed. This procedure has been checked by Bisbey and Sherman (*2*), and has been shown to be suitable for measuring the flavin factor.

Albino rats of the Wistar strain were fed the basal diet, considered adequate in all other respects, but lacking in flavin, until the body stores were depleted as indicated by cessation of weight gains, whereupon the basal diet was supplemented by daily portions of the milks. The animals were weighed weekly during the eight-week experimental period following depletion and average curves plotted. According to the Sherman-Bourquin method, a gain of twenty-four grams in eight weeks indicates the presence of one unit of the vitamin in each daily portion of test food. As rats of different strains or rats under different laboratory conditions may show variations in their rate of gain it is desirable to feed some standard product of known vitamin content as a positive control. The standard foodstuff used for the positive controls in this experiment was pure lactoflavin, a yellow-red pigment obtained from whey. It was fed to the animals at two levels, (Fig. 1) 2.5γ (1γ=0.000001 gram) daily for six days a week to one group of rats and twice this amount to another group.

TABLE 1.—Lactoflavin value of milk as indicated by the growth responses of rats

	Amount fed daily.	Number of rats used.	Average weight gains in 8 weeks.	Flavin per gm. of milk.	Average milk yield per cow per day.	Average flavin output per cow per day.
	gms.		gms.	γ	gms.	1,000γ
Composite milk:						
9–3–36*						
5 Jerseys	3.0	10	43	2	9,979	20
7 Holsteins	3.0	10	40	2	15,876	32
9–9–36†						
7 Exp. Holsteins	3.0	10	46	2	7,258	15
12–3–36‡						
5 Jerseys	3.0	10	56	2.7	5,897	16
6 Holsteins	3.0	10	50	2.7	12,246	33
Winter herd	3.0	7	....	2	....	....
Lactoflavin	2.5γ	7	22	....	....	....
	5.0γ	9	33	....	....	....
Negative controls	....	25	....	....	....	....

1. Contribution No. 65, Department of Home Economics and No. 222, Department of Chemistry.

* Cows were receiving regular college dairy ration.

† Cows were receiving a limited experimental ration.

‡ Cows were receiving the regular college dairy ration and had had good pasture until the latter part of November.

All milks were fed at the rate of three grams per day for six days a week. Composite samples of milk from two breeds of cows, Holstein and Jersey, were made early in September and again in December. Composite samples of milk from seven Holsteins on a limited experimental diet involving no green pasture and a sample of raw herd milk collected during the winter were also fed.

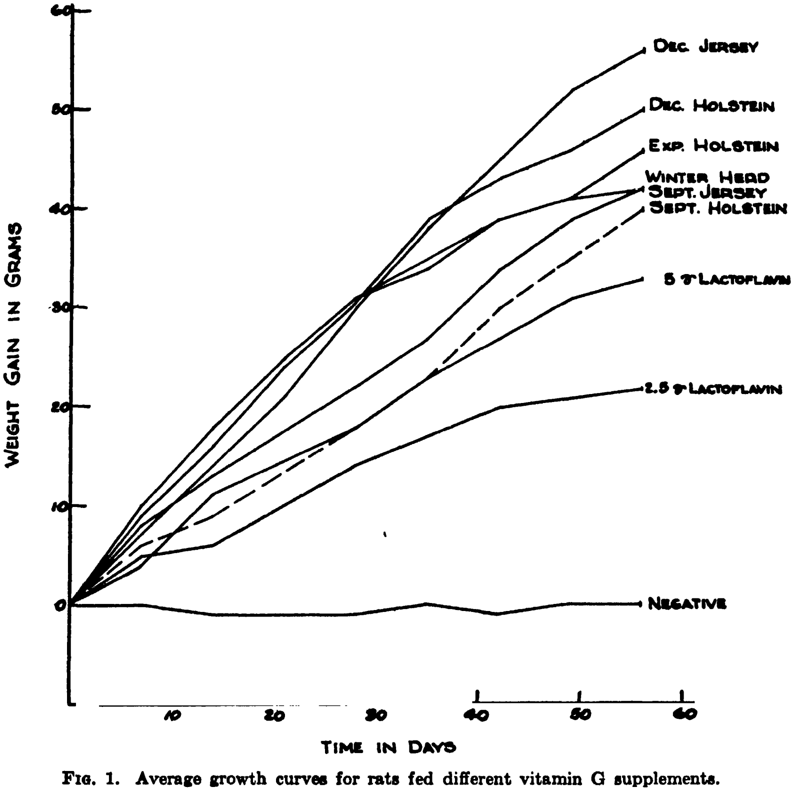

Fig. 1. Average growth curves for rats fed different vitamin G supplements.

Table 1 gives the results obtained biologically in gamma of lactoflavin per gram of milk and per average daily yield per cow. The average weight gains of the rats for the eight-weeks period are shown in column 3. The growth responses of the two groups of animals receiving lactoflavin shows the operation of the law of diminishing returns, the rats receiving the larger feedings making less than twice the gains of the other group. By comparing the weight gains of the animals receiving the milks with the positive control animals, the flavin content of the milks tested would appear to be about 2γ to 2.7γ per gram.

It is interesting to note the similarity in the flavin content of the milk from the two breeds collected at two different times of the year. The vitamin content per gram of September milk was about 2γ per gram for either breed of cows. Both breeds had been receiving a good dairy ration, but almost no

pasture because of the drought. Three months later the milk of both breeds had increased about a third in vitamin content. Good fall pasture may have been responsible for this increase.

The experimental Holsteins yielded milk of about the same vitamin content per gram as the other September milks, but produced only about half as much of the flavin per cow per day as the other cows of the same breed.

In terms of the total production, the Holsteins, on the same ration as the Jerseys, had a much larger total daily yield of vitamin G. At the end of the summer, when no pasture was available because of drought, the Holsteins produced an average of sixty percent more vitamin G than did the Jerseys. Three months afterward the Holsteins were still better producers, yielding about twice as much vitamin G per cow per day as the Jersey cows.

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The Deterioration of Silks by Light of Different Wave Lengths[1]

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INTRODUCTION

One problem confronting the research worker in textiles is the action of light on fibers. It is a recognized fact that long or frequent exposure to sunlight results in a weakening of all textile fibers.

Although silk is one of the strongest fibers it is more sensitive to light than most of the materials used in fabric construction. This sensitivity to light may be due, according to Heermann and Somner, to fineness of the filaments which favor a higher absorption of light by yarn or fabric.

Investigators disagree as to what properties of light are responsible for its deteriorating effect. Doree and Dyer attribute the destructive action to ultraviolet rays, which act directly on the fabric, or to the formation of ozone which attacks the fabric. Heermann concludes that the ultraviolet rays, rather than the ozone, cause deterioration. Both he and Stockhausen found that the kind and amount of weighting influences the durability of silk fibers.

The study here presented was carried out for the purpose of obtaining more information as to the region of the spectrum which causes greatest deterioration of pure dye and certain weighted silks. Decrease in tensile strength of the silk was chosen as a measure of its deterioration. X-ray pictures were taken in order to discover structural differences between unweighted and weighted silks and possible changes within pure dye silk which had been brought about by exposure to light.

EXPERIMENTAL PROCEDURE

A mercury arc lamp has been used as the source of light for many of the studies relative to the effect of light upon silk. Because the odor of ozone was very pronounced, and the presence of a considerable quantity of gas was definitely proven by the failure of uranyl sulphate to show any decomposition under this light source, the mercury arc lamp was discarded in favor of a light source which did not cause the formation of so much ozone. Thus any changes which the silk fabrics might undergo could be more definitely attributed to the effect of light rays rather than to the presence of a considerable amount of ozone. A General Electric S-1 lamp was chosen as the best source of light. A watt-hour meter and recording ammeter were attached in order to have a record of the energy entering the lamp during each exposure and of the actual time of exposure.

Corning glass filters supplemented by filters from the Cambridge Botanical Supply Company were used to confine the radiation to definite regions of the spectrum. Before exposing the silk specimen to radiation from the sun lamp, spectrograms of the filters were carefully studied and those filters chosen which would confine the radiation to somewhat limited regions of the spectrum.

1. Contribution No. 68, Department Clothing and Textiles, Kansas State College.

Intensity measurements of filters chosen were made by the uranyl sulphate method in order to determine the percent of light transmitted. The five filters chosen limited the radiations to the following regions:

Wave lengths transmitted in A. U.	Percent Transmission
2600-4050	70.13
3490-4050	25.57
3400-3850	13.35
3900-4600	17.01
4800-5900	11.50

A plain woven, undyed, raw-silk fabric was obtained and sent to the United Piece Dye Company for removal of the sericin and for weighting. One portion of the degummed silk was left unweighted; other portions were weighted so as to contain 53.5 percent of lead weighting, 43 percent and 50 percent of tin weighting.

Breaking strength specimens cut six inches long and one and one-fourth inches wide, then raveled to exactly one inch, were prepared from the four silks. Sets of the unweighted specimens, those containing lead weighting and the two percentages of tin weighting were exposed for 72 hours to unfiltered or to filtered rays of the sun lamp. Other specimens from each silk were exposed for 120 hours to the unfiltered rays. All specimens were kept in the experimental room in trays protected from light for at least six hours before exposure. After exposure they were returned to the trays for six hours before breaking strength determinations were made. The humidity in the experimental room was held at 64-66 percent and the temperature 69°-73° F. In a few instances the temperature ranged between 78°-83° F. and the humidity was then kept at 67 to 68 percent.

Control samples, prepared according to specifications for the test samples, were kept in trays in the experimental room in the dark for six hours before making breaking strength determinations.

The pure dye and two tin weighted fabrics, which were exposed to rays of the spectrum above 3,400 A. U. showed equal or slightly greater breaking strengths than the control specimens. Since the filter transmitting rays between 2,600 and 4,050 A. U. caused much greater decrease in tensile strength than that which transmitted rays between 3,490 and 4,050 A. U., it appears that the decrease in tensile strength under exposure to the unfiltered light source is due primarily to those rays below 3,490 A. U. Both unweighted and weighted fabrics showed greatest loss in strength when exposed to the unfiltered radiations. Deterioration appears to become more rapid for all of the silks as the time of exposure is increased beyond 72 hours. Lead-weighted samples appeared to undergo a steady and more rapid deterioration than other silks.

X-ray patterns were obtained for unweighted and weighted silks before exposure to light rays, and for unweighted and lead-weighted fabric after five days (120 hours) exposure under the sun lamp. In both cases the pure-dye diagrams were typical fiber patterns.

Elod, Pieper and Silva state that in X-ray patterns thirty percent or more of tin compound completely masks the silk. In the tests being reported X-ray diagrams of silk weighted to fifty percent gave chiefly a powder-type pattern

of the tin compound with only slight evidence of fiber pattern and the diagram of fabric weighted to forty-three percent showed evidence of fibering. Lead weighting gave a typical powder pattern, thus completely masking the fiber pattern.

X-ray patterns of lead-weighted silk that had been exposed to rays of the sun lamp for a period of five days again showed only the typical powder pattern, so it was impossible to determine from the diagram what change the fiber may have undergone upon exposure to light. The pure-dye diagram was a typical fiber pattern, apparently identical with that of the unexposed silk.

In order to determine whether the patterns of unexposed and exposed silks were identical, measurements of the intensity of the fiber patterns were made with a photometer. Before taking these measurements an axis was established as nearly as possible through the center of the diagram parallel to the fiber axis, and 30° angles were laid off on each side of this line at the center. Intensity measurements of the two outer fabric arcs were then made through the axis and through the 30° angle in each quadrant, and the ratio of the maximum intensity at the angle to the maximum intensity at the axis was calculated. In order to compensate for any error due to centering of the diagram the average of these four ratios was taken for each diagram. Duplicate patterns of exposed and unexposed silk taken on different cassettes were analyzed in this manner.

Photometric measurements of the intensity of fiber patterns indicate that patterns of silk before and after exposure to light rays are not identical. Exposure to light results in a decrease in fiber orientation. This tends to cause the long fiber arc to expand toward the character of a powder pattern.

Some Characteristics of Conductor Tie Wires

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The transfer of electrical power from one place to another is accomplished through the use of transmission lines. The majority of these lines consist of copper or aluminum conductors strung between insulators mounted on poles. The device used to hold the conductor to the insulator is known as a tie wire. (Fig. 1.)

Although the types of ties for various installations are well standardized, what happens to them under actual service conditions is not well known, and no published data is available.

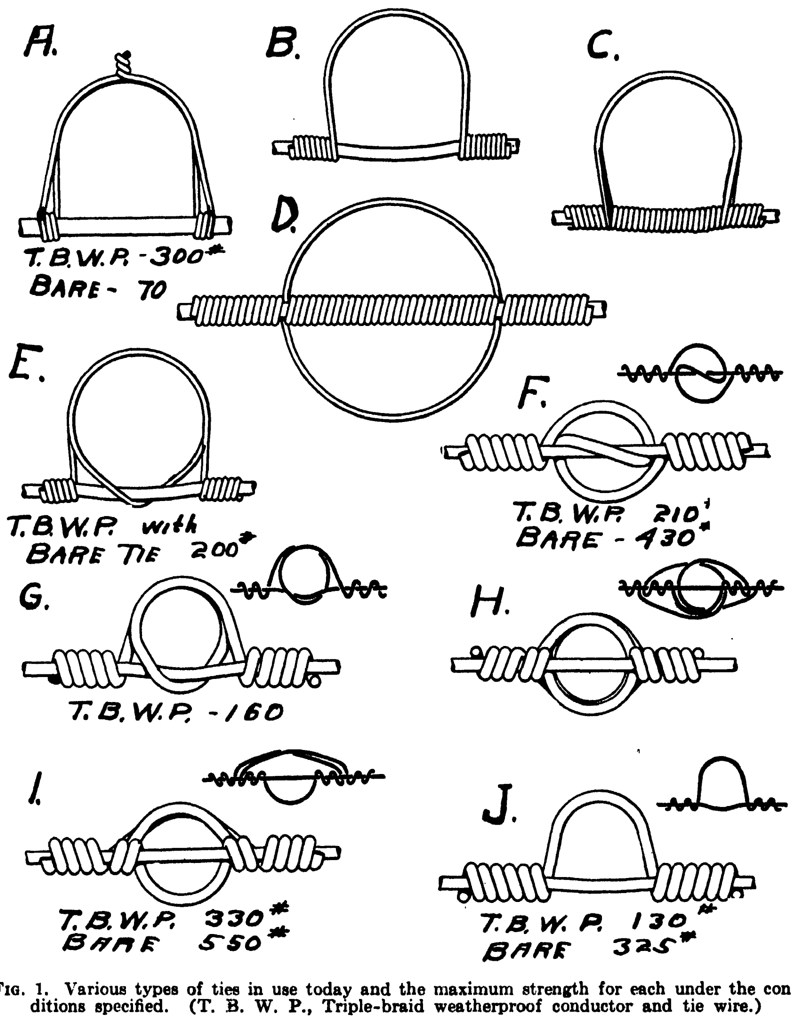

FIG. 1. Various types of ties in use today and the maximum strength for each under the conditions specified. (T. B. W. P., Triple-braid weatherproof conductor and tie wire.)

Some engineers maintain that the conductor should be permitted to slide freely through the tie, while others maintain that it should hold securely at all times. Between these two extremes is the belief that it should withstand normal differences in tension between adjacent spans, and yet slip before the line or insulator pin breaks.

It is of interest to note here that when the line is first installed the tension on each side of the insulator is the same, and the wire is subjected to no lateral stress. However, under different conditions, the stresses will not be the same, due to changes in temperature, and unequal ice and wind loadings.

Line wires are usually designed for a maximum tension of one half the ultimate strength. For No. 6 B. & S. gauge copper this working stress would be 500 pounds. Approximately three fourths of this, or 375 pounds, would be ice and wind load. Therefore, if a tie wire is to hold under ordinary conditions of service, it must withstand an unbalanced pull of 300 to 400 pounds, since the ice would not fall from all spans at exactly the same instant.

To determine the characteristics of various standard ties a series of tests was made in the applied mechanics laboratory at the University of Kansas. These tests consisted of mounting a standard insulator and pin in the testing machine, tying a conductor to the insulator, and pulling the conductor through the tie. The results of these tests are given in the accompanying diagrams. (Figs. 2 and 3.)

The maximum tension varied from 100 to 300 pounds at about one inch strain in the majority of cases. Beyond this point the stress decreased. In only one or two cases was the maximum stress equal to the calculated working stress of the conductor.

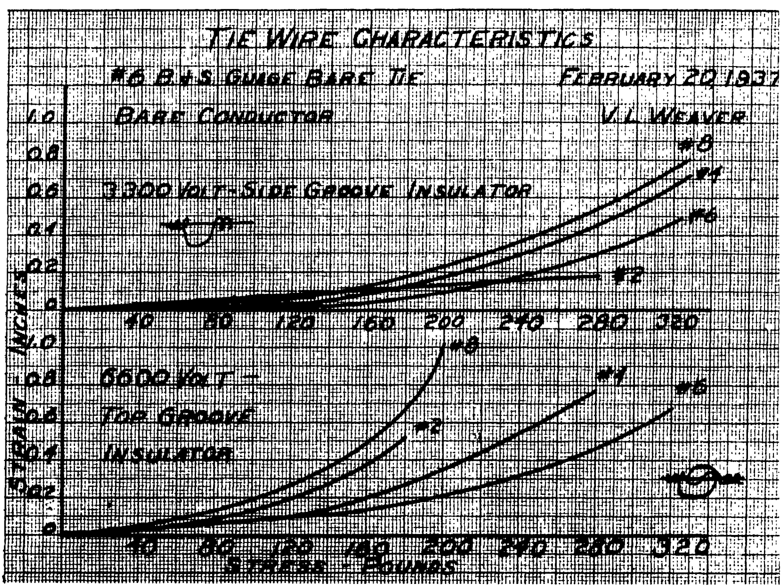

Fig. 2. Curves showing relation between stress and strain for a bare tie wire on a bare conductor for both side and top groove insulator.

The results of a triple braid weatherproof (T.B.W.P.) conductor on a 3,300-volt side-groove insulator for various sizes of conductor and both T.B.W.P. and bare soft drawn tie are as follows:

With a No. 8 gauge T.B.W.P. tie wire the maximum stress varied from 130 pounds at 0.66 inch strain for No. 4 conductor to 110 pounds at 1 inch strain for No. 8 conductor. No. 6 and No. 2 conductors showed a maximum stress of 125 pounds at 0.85 inch strain and 120 pounds and 1 inch strain, respectively.

With No. 6 bare tie, the maximum strain was 0.8 inch for all four sizes of conductor with the exception of No. 4 which had a strain of only 0.7 inch. The maximum stress was 150, 150, 220, and 240 pounds for conductors number 2, 4, 6 and 8, respectively.

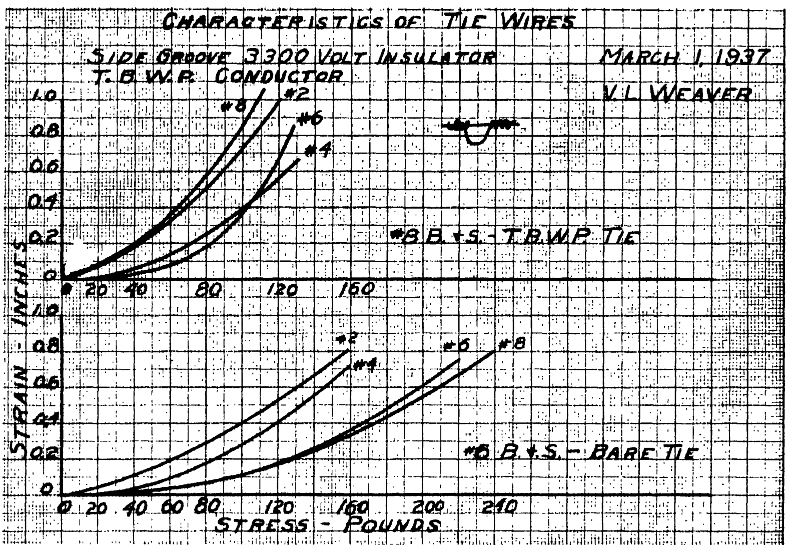

FIG. 3. Curves showing relation between stress and strain of a weatherproof conductor with both weatherproof and bare tie wires on a side groove insulator.

The bare tie wire gives up to 100 percent higher maximum stress than the T.B.W.P. tie wire and the strain does not exceed 0.8 for maximum stress. From a standpoint of strength, then, the bare tie wire would be superior to the weatherproof tie. However, the bare tie wire does have the disadvantage of stripping the insulation from the conductor. The author believes that this is of little or no importance, especially when weighed against the fact that a weatherproof tie will work loose when subjected to alternate pulls, whereas the bare tie would be affected only slightly.

These results and the type of tie used are shown graphically in figure 3.

A No. 6 soft bare tie wire on a bare hard drawn conductor and side groove 3,330-volt insulator shows a maximum stress of 320 pounds for sizes 8, 4, and 6, and 280 pounds for size No. 2. The strain at maximum tension varied from 0.2 inch to 0.8 inch, being 0.2, 0.5, 0.7, and 0.8 inch for Nos. 2, 4, 6, and 8, respectively.

The bare tie and bare conductor on top groove, 6,600-volt insulator showed a wider variation of maximum stress, varying from 180 to 320 pounds. The values for conductors Nos. 2, 4, 6 and 8 are, respectively: 180 pounds stress at 0.5 inch strain; 280 pounds at 0.8 inch; 320 pounds at 0.7 inch; and 280 pounds at 1.0 inch.

These results and the type of tie used are shown graphically in figure 2.

These results would tend to show that there is need for some improvement in the standard ties in use today. Since the working stress of the conductor will frequently exceed the maximum holding power of the tie, the conductor will slide back and forth through the tie, gradually working it loose, causing unequal sags in adjacent spans, and finally complete failure of the tie.

These curves were obtained by gradually increasing the load on one side of the insulator. By changing the rate of application of the load, or by applying the load first to one side and then the other, combined with lateral vibrations of the conductor, different results might be obtained. Actually, then, considerable additional research is needed before any definite conclusions can be made. In the author's opinion, however, the above variations would decrease rather than increase the ultimate strength of the tie.

Radioactive Properties of the Subterranean Waters of Ellis County, Kansas

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INTRODUCTION

Soon after the discovery of Becquerel rays in 1896, tests were made on ordinary matter to see if all matter were radioactive. Although there is evidence to show that all matter is radioactive, it has been found that the greater part of the observed effect is due to traces of radioactive materials scattered over the surface of the earth. Moreover, determinations of radioactivity have been made in relatively few localities.

Since little work has been carried out in this part of the country on the radioactive properties of subterranean waters, the following problem was thought worthy of consideration: To determine the radioactive properties of the subterranean waters of Ellis county; and to determine the relation between these properties and depth, if any.

HISTORICAL DATA

The discovery of radioactivity followed closely on that of X rays. In 1896 Becquerel (*1*) found that uranium was the source of penetrating rays, and coined the word radioactive to describe their property. The intensity of the rays from various salts of uranium were found to be proportional to their content of this element.

The electroscope method (*1*) of detection was found to be extremely sensitive compared with the other methods, and searches for other radioactive elements were undertaken with its aid. It was found that certain uranium minerals possess an activity several times higher than that of uranium metal, gram for gram. This suggested the presence of a new element more active than uranium. Finally, at the end of 1898, the Curies, together with G. Bemont, were able to announce the discovery of radium.

Many other discoveries followed, until today we are acquainted with almost forty types of radioactive atoms having atomic weights equal to or greater than 206. Fajans (*2*) lists these radioactive elements under three series: uranium, radium, actinium, and thorium.

The radioactivity of water may be due to traces of radium salts dissolved in the water. It may be due to some other product of the thorium or actinium series, probably an emanation. The greater amount is usually due to radium or radium emanation dissolved in the water (*3*).

In the tables of the radioactive series, it will be noted that when one substance changes into another, a radiation of alpha, beta or gamma rays, in some cases all three, is given off. The radiations ionize the air and render it conductive. The conductivity of the air becomes a measure of the radioactivity of the substance. This is proportional to the rate at which a charged body loses its charge. Thus the intensity of a radioactive substance can be measured (*4*).

The unit of radioactivity, called the curie, is based on the mass of an active substance (*4*). The curie is the amount of emanation in equilibrium with one gram of pure radium.

From tables of the radioactive series it is seen that the disintegrated product

of radium is emanation, a gas. It was discovered in 1900 by Dern (2) and is known as radon. When disintegrating, radon gives off alpha particles and changes into radium A.

APPARATUS

The apparatus used in this work is similar to that used by Ramsey (3). It was made in the laboratory from bits of scrap materials. The electroscope proper was made up of two parts, the emanation chamber and the box containing the leaf. The emanation chamber comprised a cylindrical can seven centimeters in diameter and thirteen centimeters long. Two small stopcocks were inserted in the can to permit pumping in the emanation. The rectangular box containing the leaf was $10 \times 10 \times 15$ centimeters. Windows were cut in the box so that one could see the leaf. An insulated charging contact was inserted in the side of the box. The two lids were fastened together and a hole cut through the center of both.

The leaf system comprised a thin copper wire with a small sheet of copper soldered on the one end. The wire passed through a hole in the lids and was fastened in place with sulfur which served as an insulator. The leaf was cut from a piece of Dutch foil and fastened to the copper sheet on the insulated wire. A piece of glass was fastened to the front window and a piece of oiled paper with a scale on it was fastened to the back window. The shaking can was a gallon can with a screw cap on top and two small stopcocks in the side, so that there was about twice as much air as water. A thermometer was inserted in the top. Other apparatus comprised: ebony rod, piece of wool, voltmeter, small light, wires and direct current.

CALIBRATION OF ELECTROSCOPE

The instrument was calibrated according to the work of Ramsey (3). The calibration is very important and should be made several times to insure accuracy. Its capacity was found to be 1.96 cm. The standardization of the electroscope can be made one of two ways; first, by comparing the unknown solution to a standard solution; and second, by the use of Duane's empirical formula (3).

COLLECTING WATER SAMPLES

The water was collected in one-gallon jugs from the various wells. The location and depth of the wells were also taken at that time. The water must be handled as carefully as possible so that the emanation will not escape. The samples were taken to the laboratory and tested within forty-eight hours.

METHOD OF PROCEDURE

After the electrosope was calibrated and standardized, the next step was to determine the constants of the apparatus. Some of these constants were: capacity of electroscope; volume of bulb, pump, and connection tubes; volume of water in shaking can; volume of air in shaking can; volume of ionization chamber; and inside surface of ionization chamber. These constants were determined according to Ramsey's procedure.

The water was filtered before being tested. A combination of the shaking and boiling methods was used to expel the emanation from the water. The water in the shaking can was heated to about boiling and then shook for a definite time to expel the gas from the water. The water and gas were cooled to room temperature before the gas was pumped into the electroscope.

A complete set of ionization observations for a given sample of gas required three hours for completion and involved two sets of readings of ten-minute periods, one at the beginning of the three-hour period, the other at the close. The leaf was charged to near maximum deflection and the charging contact was grounded through the case of the electroscope. The deflection of the leaf was noted, as was also the time. At the end of ten minutes the deflection was again noted and recorded. After the first set of readings was completed the leaf was grounded and the gas was allowed to stand in the emanation chamber for three hours, at the end of which readings were again taken and recorded. The leaf was charged to the same potential each time. The physical conditions of the room were kept as nearly constant as possible.

After the two sets of readings were taken, air was pumped through the emanation chamber for thirty minutes to remove the gas. The electroscope was then allowed to stand for several hours before the next sample was tested. Before every set of readings, the natural leak of the electroscope was determined and this subtracted from the leak due to the gas put in the electroscope.

To find the amount of emanation in the emanation chamber, the deflections were substituted in the equation referred to under "Calibration of Electroscope." Hence, to calculate the amount of emanation per liter of water, the following formula was used:

$$E = \frac{i}{V_1} \frac{(V_2 + a V_1)}{V_1} \frac{(V_2 + V_3 + V_4)}{V_4} e,$$

where i is the ionization current, V_1 is the volume of water in the shaking can, expressed in liters, V_2 is the volume of air in the shaking can, expressed in liters, V_3 is the volume of bulb, pump, and connection tubes, V_4 is the volume of ionization chamber, a is the absorption coefficient of water for radium emanation, e is the amount of emanation in V_4 and E is the amount of emanation per liter of water.

RESULTS

Part of the results obtained in this investigation are given in the following table. The amount of emanation per liter, at the beginning of the three-hour period, at the end of the three-hour period, the average emanation in curies per liter, the sample number, its depth, and location are given in the table.

Sample No.	Location	Depth in feet	$E_o \times 10^{-12}$ curies/1	$E_{max} \times 10^{-12}$ curies/1	Av. $E \times 10^{-12}$ curies/1
1.	S17, T15, R18W	3,300	17,018	17,295	17,156
2.	S17, T15, R18W	2,385	18,700	20,210	19,455
5.	Rainwater	....	12,560	27,250	19,905
8.	S7, T12, R17W	3,732	47,464	86,735	67,100
11.	S9, T13, R20W	3,615	16,786	116,886	66,826
14.	S9, T13, R19W	3,540	98,852	106,173	102,513
15.	Distilled H_2O	....	0	0	0
18.	S7, T14, R16W	40	22,016	42,278	32,122
22.	S24, T12, R19W	180	8,450	10,563	9,506
24.	S21, T11, R17W	3,350	37,912	49,841	43,872
28.	S17, T15, R18W	3,560	25,333	58,212	42,773

E_o is the emanation at the beginning of three-hour period.

E_{max} is emanation at the end of three-hour period.

Some of the constants of the apparatus were as follows:

C —1.96 cm.—Capacity of electroscope.

V_1—1.545 liters—volume of water in shaking can.

V_2—2.235 liters—volume of air in shaking can.

V_3—224 cu. cm.—volume of bulb, pump, and connection tubes.

V_4—497 cu. cm.—volume of ionization chamber.

S —363 sq. cm.—inside surface of ionization chamber.

CONCLUSIONS

The emanation was measured from twenty-eight samples of water taken from different parts of the county and at different depths. The amount of emanation varied from zero curies per liter to $102{,}513 \times 10^{-12}$ curies per liter.

No relation between the depth of the wells and the amount of emanation was found. However, a tendency towards increased emanation appeared in samples from the west-central part of the county.

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A Note on the Measurement of Wave Length by the Diffraction Grating

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The measurement of the wave length of some visible radiation such as the sodium or mercury spectrum is a familiar experiment in college laboratories of physics. Without the use of a spectrometer, the source of light is placed two or three meters distant from the grating and the virtual images of a slit, placed in front of the source, are seen by placing the eye back of the grating. Most of the laboratory manuals merely say "The scale readings of images are noted."

In several laboratories observed by the writer, this location of images was done by having one student move a pencil along a two-meter stick parallel to the grating. This method was used in the writer's laboratory for several years, but even in a semidarkened room the pencil is difficult to see, and hence considerable error is introduced. In addition, this location of images is not consistent with the care taken in ruling the original grating, and introduces an idea of crudeness into the measurement that allows the student excuses for the introduction of other more or less slipshod methods of measurement. The experiment, as observed in other laboratories, is arranged all in the space of one meter, the images being viewed on a half-meter stick as a background. Errors in this set-up run as high as seven percent.

In order to determine the position of the images of the slit, two small three-volt radio dial lamps are mounted in sockets on small rods that fit optical bench holders. These move along a meter stick or optical bench, parallel to and about two meters from the transmission grating. A rheostat in series with the lamps reduces the potential across the lamps so that the filaments are just visible. The lamp on the left is moved until its filament coincides with the green line, for instance, of the mercury spectrum. One may work with quite wide slits since the small filament can be centered on the image with remarkable accuracy simply by inspection. The right-hand lamp is adjusted to the position of the image on the right. If the spectrum is weak or strong, the filaments can be adjusted to the proper contrasting intensity. For reading the scale, another small lamp with switch on a flexible cord is quite convenient.

A comparison of the values of wave lengths obtained using the old method as described above and the new method is shown below. The data for the old method is limited since only a few scattered records could be gathered, but they are quite typical. Records have been kept on the newer method and those values shown below are practically all from last year's class in General Physics. The grating was a replica of 15,050 lines per inch.

It will be noticed that the old method gives results that deviate 100 to nearly 300 angstroms on the mercury line 4358A. The average percentage deviation is four percent with some values as high as seven percent. With the new method, the average deviations are respectively, 28, 24, and 27 angstrom

units for the yellow,[1] green, and blue lines of mercury. The average percentage error for all the values is 0.5 percent.

Small error is not necessarily the main object in an experiment, but if more precise values can be obtained without sacrificing other objectives and with a method that will seem more appealing to the student; one will find that students will have more respect for the apparatus; they will in turn be more careful in their measurements and write better reports.

Two simple forms of mercury vapor lamps are available at small cost, depending upon the laboratory facilities. For one dollar, one lamp was made by a local neon sign company. This consists of two of the standard sign ends with electrodes. These are sealed together. A little argon and mercury are introduced and the tube sealed off. A small high-tension transformer or spark coil will operate it. The tube is now six years old and apparently in good condition yet.

The half-wave mercury-vapor rectifier 866, as suggested by Ramsey[2] can now be purchased for $1.45 and can be operated with facilities ordinarily found in the laboratory.

1. The yellow line is the average of 5770 A. and 5791. The slit was too wide with these measurements to resolve the lines.

2. Am. Phys., Teacher 5, 87 (1937).

The Function of Feeling in Adjustment

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Feeling is a primitive datum of organic behavior capable of sentient experience. The phenomenon of feeling is so integral to the phenomenon of stimulation that either may be defined in terms of the other. Feeling is the registering of stimuli, and stimulation is the registering.

The relevancy of adjustment behavior to feeling is made possible by the functioning of feeling in behavior. Were feeling exclusively subsequent to adjustment, the types of feeling would be as multiple as the expressions of behavior. An adjustment pattern is relatively predictable simply because an essential factor of the pattern is a feeling element appropriate to the overt expression. An adjustment pattern is thus intimately related with feeling since feeling is itself the motivation of behavior.

The behavioristic explanation of feeling is only partially defensible. Adjustment behavior conditions feeling, but it is not the sole causal factor of it. The relevancy of behavior to feeling, as well as feeling to behavior, is explicable because an incipient behavior is latent in feeling, and because a feeling tone is at least partially determinative of the behavior pattern itself. The concommitant parallelism of internal experience and outward manifestation is not a cogent argument for the causal functioning of the one exclusive of the other. The insistence upon the causative feature of behavior exclusive of factors not objectively observable is a prejudice unique to behavioristic methodology.

The most elemental feeling responses of an organism are strictly physiological, and arise as the tonal accompaniment of organic behavior. When the reaction of an organism to stimuli is determined exclusively by feeling tones, it is the feeling incident to the impact of stimuli that initiates the response. To the extent that feeling determines adjustment, it performs the function of a nervous system, and the development of a centralized nervous system is biologically justifiable only by the greater efficiency with which adjustment response is made. The response initiated by a complex neural system is more accurate than that made possible by an undifferentiated feeling, and therefore reaction mediated by a nervous circuit is more effective in adjustment than feeling is.

The function of feeling, however, is identical with the function of the nervous system. Both elemental feeling and a more differentiated nervous reaction distribute a localized stimulation, thereby informing the organism as a whole of the events peculiar to its parts. Since feeling broadens the area affected by a localized stimulus, the reaction to stimulation is appropriated not only for the areas immediately stimulated, but for the organism itself.

An explanation of the determination of adjustment by feeling is not to be found either in the feeling itself or in the behavior which is its manifestation. The feeling which gives rise to overt expression is a manifestation of another phase of behavior since it is the meaning of the situation to the organism in which adjustment is made that determines the type of feeling experienced in the adjustment.

Feelings condition the meaning of a situation no less than the meaning of a situation conditions feelings. Since overt expression conditions feeling, and since feeling qualifies overt expression, the relation of feeling and overt behavior is reciprocal. A feeling which arises in a particular situation cannot be understood apart from the meaning of the situation to which the feeling itself is a response.

The meaning of an adjustment situation for the organism making its adjustment is the key to an objective interpretation of overt behavior. A particular behavior may express a feeling experienced by the organism, but the feeling itself cannot be interpreted merely by a description of the overt behavior. Feeling may be described in terms of overt behavior, but it cannot be analyzed by description. An analysis of behavior involves a nonfeeling factor in feeling itself, and only as the meaning of an adjustment situation can be detected by an objective interpreter can conation be discovered in the observed behavior.

Feeling is an orienting phase of behavior, since an organism becomes oriented to its surroundings through the mode of feeling characteristic of the situation. A specific stimulus give rise to a specific mode of feeling and a specific mode of feeling is associated with a specific adjustment situation. An analysis of behavior is therefore circular since there is a reciprocal relation of situation and feeling: the feeling registers the situation, and the situation defines the feeling.

Feeling tones arise in the relationship of an organism to the referent of its adjustment which are characteristic of the behavior relation. Without feeling to give vitality to the relationship, adjustment would be the association of lifeless entities. Adjustment, however, is dynamic, and the feelings which arise in the dynamic relationship are a function of the meaning of the referent to the organism making its adjustment. Feeling is a derivative of the nonfeeling meaning of the situation to which the organism adjusts.

Adjustment to a factor regarded as capable of supplementing deficiency is motivated by felt need, and since the feeling of deficiency determines the type of reality which is sought, the felt deficiency influences the meaning of the referent to which adjustment is made. A felt need not only motivates behavior, but it also determines the adjustment set which controls the behavior in behalf of the need. Only that actuality can be discovered which is sought for, and since the direction of the search is conditioned by the organism's need, the referent to which adjustment is made is in part a product of the felt deficiency.

Adjustment situations present a perpetual novelty to the organism and therefore save it from stereotyped reactions. The novelty of a situation is responsible for the feeling tone of adjustment-behavior since the novel stimulus elicits a response whose pattern is not identical with a former response. Novelty of stimulus demands novelty of response, otherwise response would be irrelevant to stimulus, and stimulus would be ineffective for appropriate adjustment.

The novelty of response which is a requisite for survival is a function of feeling. Although feeling makes possible a novel reaction, its adjustment value is derivative from the meaning of the situation to which adjustment is made. The feeling tones of physiological reaction supply the data from which the

meaning of a situation arises, and yet the meaning of an object whose stimulation gives rise to a feeling response is itself determinative of the feeling. Purposive behavior thus involves the functioning not only of feeling, but also of a non-feeling factor in feeling itself.

Purposive behavior involves the meaning of the situation as the very content of the organism's awareness of the presence of a factor registered by feeling, and adjustment to the situaiton is in turn creative of a specific feeling only because the organism has a definite set toward the situation. The feeling which the organism experiences depends on the valuation it places upon the referent of adjustment, and the valuation which is placed upon the referent to which adjustment is made depends upon the feeling elements of the experience in responding to it.

The concepts of stimulation and feeling are applicable to the entire phenomenon of sentient behavior whether the behavior be a response of an elementary structure or of one more developed. The psychological concept of attitude is comparable to the physiological concept of feeling, since attitude is for a highly developed central nervous system what feeling is for the elementary structure. Just as all nervous activity is not mental, so all sentiency is not attitude, but, the rudimentary phase of attitude may be generically interpreted as feeling, since attitude and feeling are comparable registrations of stimuli.

A Concept of Gradient of Personality Integration as a Substitute for Freudian Concepts in Problems of Mental Hygiene

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Useful as the Freudian concepts have been in describing conditions of maladjustment in personality, they have been open to certain objections. Some of the foremost of these have been: first, they tend to anthropomorphize forces or to make tendencies appear to be personalities; second, their pan-sexualism does not properly emphasize or describe activities of life which are not properly called sexual; and third, the ego-super-ego-id division of personality is too crude properly to describe the complex functions of a person and to relate these functions to the conditions of life which give him the status implied in personality.

The tendency to use more simple methods of description might be expected to arise out of professional psychiatric practice, in which only a restricted sampling of cases, and a restricted sector of case situations would be presented. The work of clinical psychologists, however, with school children who come from all cultural organizations and who adjust well or badly in a great variety of ways, has led to a concept of levels of personality adjustment, or levels of life-striving. The writer first came into contact with such a concept through work in the Kansas Child Guidance Clinics under the direction of Dr. Geo. A. Kelly.

The implication of such a concept is that the higher levels of striving exercise dominant control over the lower levels. The writer envisages this control as analogous to the dominance of the higher neural and symbolic organizations over the lower ones as treated by Travis in his book, "Speech Pathology." The higher levels organize, limit and inhibit the activities of the lower levels, breaking up and interfering with the lower-level organizations in order that the higher may be achieved. In problems of speech pathology, Travis envisages the mechanism formerly used only for eating, a lower-order activity, now integrated into a new pattern of activity by a new gradient, the gradient of symbolic speech. In problems of personality adjustment, we can think of such an activity as participation in married life, formerly organized only with regard to satisfaction of sexual cravings, now integrated around a higher-order motive, that of performing an activity which might be called mutual appreciation of all areas of life, and still later, this might yield to a higher form of integration which might be called organization, consciously patterning activity, so as to make a contribution to community life.

The term "gradient of personality integration," as we use it, does not refer to the way in which a specific act is performed. The gradient of personality integration, rather, refers to the type of organization customary to a person in meeting life situations from time to time. These are more or less constant levels of organization with reference to the whole personality structure; which pervade enough of the personality to cause large areas of conflict in mental disease, or to organize successfully all the strivings of the individual in mental health. There are listed below some levels at which a personality may be

envisaged as being organized. These coexist in the personality, no matter how high its development may have progressed, but each is modified and controlled by the next higher level.

LEVELS OF ORGANIZATION WHICH MAY BE USEFUL IN DESCRIBING A PERSONALITY

1. Good physical health: a level of integration of physiological activities, such as circulation, digestion, metabolism, respiration, etc.
2. Adjustment: a level of integration at which the organism seeks food, comfort, and amusement in the outside world without recognizing responsibility to it.
3. Functional relationship: a level of integration on a "give-and-take" basis. The individual may "trade" with society, but does not respond as in an organic relation to the larger society.
4. Limited social-organic relation: the individual lives in accord with a principle which integrates him into small groups in member-relationship, but which does not exercise dominance over wider concerns.
5. Extended social-organic relationship: the individual lives as a member of a world-brotherhood, or member in a world, and is able to govern his activities accordingly.

There is implied in these concepts a gradual increase in consciousness from the lower part of the first to the top of the fifth. It should also be understood that other gradients could be described and levels of dominance could be graded more closely. These gradients should be understood as varying in experiential content with the age and maturity of the person, with his life-experiences, and with his intelligence. The content, in terms of life experience and vision of society, is different from person to person. Likewise, some kinds of experience may be more easily held under the dominance of the higher centers in one individual than in another. In most persons, sex is an organization of forces which is hard to control, yet it gives relatively more trouble in some personalities than others.

There is a distinction between a gradient of personality integration and such a gradient as intelligent activity, in addition to the more constant nature of the former. *A gradient of personality integration is comprehensive, that is, it organizes all activities of life.* Such activities as getting a lesson require a very complex and highly structured pattern of activity, but the controlling gradient for the activity is limited, ideally, to logical and mathematical relationships perceived independently of their effect upon the organism. That is, it is referred to rules of logic which are posited as existences independent of the individual. The question around which the activity of such an organization might function could be, "Is Heraclitus' theory of motion sound?" A question which might concern a gradient of personality integration might be, "How can I always be right?" It must be emphasized, however, that this question is only descriptive of the need to be met, and may not be definitely and consciously recognized.

In mental hygiene and personality problems, it seems better to use a concept of curiosity as the manifestation of the organizing force in personality than to use such terms as "life-urge," "libido," or others. While the term "curiosity" is too likely to be interpreted as mere intellectual curiosity or as *seeing* spacial or mathematical relations, it implies at least a tendency upon

the part of the individual to organize his activities into certain patterns, a phenomenon which can be observed in the higher animals as well as in human beings. Deficiencies in curiosity, or perverted modes of expression, may be checked up to many causes, predominantly sexual in some cases, physical in others, and poverty of experience or low mentality in others. This curiosity, constantly structuring the life-experience at different levels, can be used in describing different states of mental sickness or health. *It must not be thought of as simply "curiosity to know," but rather as "curiosity to experience."*

Using this as a background for the new concept, let us trace out some of the features which are found in the psychoneuroses and psychoses. Neurosis would be thought of as an inability to structure experience satisfactorily at the higher levels, with curiosity still oriented toward them, while psychosis would be thought of as lack of activity of the curiosity in the higher levels, and preoccupation with more or less intensive activity in structuring the field of experience at the first and second levels described above, the level of health and the level of adjustment. In the manic-depressive psychosès, there will be elementary structuration at the third level. Narcissism, which is an important concept in Freud, may be represented as a tendency to structure the lower levels excessively, there having been frustration or inability to perceive in the higher ones.

In hysteria, the Freudian concept is that a socially unacceptable mental conflict is converted into a physical symptom. In the gradient concepts we would say that the individual has been unable to structure life in a satisfying manner at some level near the third one which we have described as the level of functional relationship. This gradient is not sufficiently well formed, however, to permit integration of this frustration into the material of this level, and curiosity is directed toward the more physiological level below. Unhappy, the individual seeks to see the pattern of life here, and effects a disruption of this level in his bewilderment, which comes to light as a physical symptom. In the obsessive neurosis, or compulsion neurosis, a person exhibits what Freud calls the split-ego, which we would describe as an attempt to solve bewilderment by dividing the activities of the third or fourth level into separate gestalten and figuring them highly, trying to close two patterns of activity at the same level. This dual authority at this level of adjustment results in ambivalent attitudes toward various items of the life-situation, and in spasmodic action of the lower activities. The description of the obsessional can be likened to the neural confusion of the stutterer. The stutterer's speech organs, attempting to respond to ambiguous authority, pick up small bits which do not make complete expressions, and repeat them, blocking, doing this, then that, and generally giving a feeling of insecurity and frustration. The obsessional, with his repetition of thoughts, and his hair-splitting, his backing up and starting again, his vacillating attempts, first to be "bad" and then to be "good" makes a picture similar to this in the personality realm. The inhibited states represent a similar picture, though it is one in which there is more tension and less free movement. Shulte has described paranoia in a manner compatible with these concepts.

The work of analysis is, as in Freud, abreaction of experiences, but is not thought of as a discharge of emotion from any one trauma. In analysis, the

patient comes into living contact with evidence of maladjustment, and with help from his analyst, the reassurance of a personal confidant, and ability born of further experience, fills in the faulty structure of experience as it had been with a new dynamic concept of experience as it can be.

Emotional education takes the form of tracing out the outlines, not as intellectual cognition, but as deeper experience, of successful patterns, or a gentle disruption of satisfaction at present levels so that curiosity will be turned to higher ones. The precautions necessary are that the present organization should not be broken down completely and that the individual not be challenged beyond his ability to integrate experience. Thus are constructive measures and remedial efforts integrated by the same theoretical explanation.

Do these concepts make the structure of personality more easily understandable; and do they make the treatment of psychoneuroses more comprehensible? The foregoing discussion should clear up the matters of anthropomorphism and of pan-sexualism, if these are real objections to Freudian concepts. The present concepts may be open to more grave misinterpretations than the others, however. Since the gradient concepts are more impersonal than Freud's, and hence more flexible in fitting various individuals and various problems, they should give more workable description of the individual. It is easier for the writer to envisage the different varieties of activities carried on under dominance of any of these gradient concepts than in Freudian concepts, though this may not be inherent in the concepts. The idea of curiosity as a substitute for libido seems to fit in with the activities of a person in organizing experience and to keep one oriented toward the objective facts in this person's environment as well as toward his internal conflicts. This concept seems also to give a more unitary picture of mental-hygiene activity as both remedial and preventive.

The Effect of Configuration Upon Contrast

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We know Hering's laws of contrast. First, the contrast effect is always in the direction of the greatest qualitative opposition. Second, the more saturated the inducing color, the greater is the contrast effect. Third, the nearer together the contrasting surfaces, the greater is the contrast effect. Fourth, color contrast is at its maximum when brightness contrast is eliminated. Fifth, the contrast effect is enhanced by elimination of contours.

Here we have what may be called the analytical method of approach. That is, if a gray, for instance, has a larger part of black adjoining it than a similar gray of the same size, it would be lighter. It is a question of what *part* is alongside of another *part* that determines the result, according to Hering. It is not the question of whether the critical part concerned is caught up in a pattern or not. It is merely the question of a part affected by a part.

But the Gestaltists have questioned this analytical approach. Wertheimer claimed that contrast effect could not be accounted for by the Hering laws, but only by the principle of configuration.

As an experiment confirming this idea he made a black cross upon a white background with a piece of medium gray inserted in the upper arm and the same kind and size of gray inserted in the lower right-hand corner, but outside of the design. Wertheimer discovered that Hering's laws are contradicted, that the upper or inserted gray is not darker, but lighter than the other gray. The same effect can be seen in the black H and black I figures. Here the gray between the arms of the H should be lighter than the gray inserted within the I because of the former having more black around it. But the effect is just the opposite.

Benary continued Wertheimer's experiment with various figures and came to a like conclusion, namely, that it is the Gestalt or configuration that determines the gray quality, rather than the part adjoining it. In other words, it is the inclusion of the upper gray within the design that produces this lighter effect, while the darker effect of the lower gray is due to the fact that it is outside the design and the design does not have much effect upon it.

The writer carried on Benary's experiment with a better control of conditions. For instance, instead of letting the subject look from one to fifteen seconds at a figure, thus permitting the formation of positive and negative after images and vitiating the first and true perception exposure, he cut down the time to twenty-five sigmas. This falls below the time limit for eye movement which was thus eliminated as a possible explanation of results.

Eight series of figures were prepared. The first was a repetition of the same kind of figures, with a little modification, as employed by Benary. The results are seen in the following tables:

Reports for ten Observers from eleven Black Designs on White:

Obs.	G_oD	G_iL	G_oL	G_iD	Equal	No report	Totals
C	8	36	11	1	9	12	77
F	51	0	1	8	7	10	77
G	49	4	1	8	6	9	77
Hi	3	31	1	0	7	2	44
M	49	5	0	8	9	6	77
S	60	1	0	5	5	6	77
Su	27	25	3	4	14	4	77
T	58	3	0	6	3	7	77
Y	24	0	0	3	2	44	73
Z	31	0	1	2	2	8	44
Totals	360	105	18	45	64	108	700

465 63

Reports for ten Observers from seven White Designs on Black:

Obs.	G_oD	G_iL	G_oL	G_iD	Equal	No report	Totals
C	0	15	6	18	8	2	49
F	6	0	1	34	5	3	49
G	5	3	4	30	4	3	49
Hi	0	2	5	10	7	4	28
M	4	2	2	30	4	7	49
S	0	2	0	41	3	3	49
Su	5	6	8	18	8	4	49
T	10	0	0	30	3	6	49
Y	1	1	0	6	5	32	45
Z	1	1	2	12	2	10	28
Totals	32	32	28	229	49	74	444

64 257

Out of 700 observations, as one may see, 465 resulted in the inserted gray being seen as lighter, and only 63 being seen as darker. Out of 444 observations, white designs on black, we found the opposite effect, but also contrary to Hering's laws; 257 declared the upper gray as darker as compared with 64 as lighter. This confirms Wertheimer's and Benary's observations that the Hering laws do not account for these effects.

But is it due to configuration? In order to answer this question, mutilated designs were prepared that did not look like anything, with the critical grays placed as above, one inside and one outside of the mutilated figure. The results were the same as found by Benary, but my observers said that the inside gray was not an integral part of the design. It did not have about it the "zugehörigkeit," as the Germans say. The so-called inserted gray appeared to be an intrusion. So we cannot say that this strange effect is due to configuration.

In order to see whether the design had such a strange effect upon the inserted gray and the background very little, as we would expect from the Gestalt theory, a third series was made. This was made by having duplicate designs, but in one of these the contrast between figure and ground was diminished by pasting a similar gray alongside of the outside gray upon the background, thus testing the effect of the design upon the outside gray. Another pair was made with one design made of a similar gray to the critical gray, thus testing the effect of the ground upon the inside gray. The results show that the design has a decided contrast effect upon the outside gray and

the ground has a decided effect upon the inside gray. These facts question, therefore, the contention of Wertheimer that it is the configuration that *determines* the quality of the inside gray.

A fourth series was made of figures showing the inside gray completely submerged in a figure with no border touching the background. Observers were asked to observe under two attitudes. First, to consider the gray as part of a pattern, and second, to consider the gray surrounded by mere black without thinking of the figure. Here the results show that there is no clear difference in the quality of grays as observed in abstraction from the main design and with the whole figure integrated.

The fifth series consisted of a series of figures, such as an L where the horizontal bar was a critical gray, thus integrating itself into the figure and completing it. Another critical gray was placed alongside of the vertical bar which did not integrate. Here we found that the completion gray does not show results in accordance with the configurational theory.

Our sixth series consisted of good and bad letters in which, for instance, the horizontal bar of an A was misplaced as compared with the gray horizontal bar of a good A. Here we found results in accordance with Wertheimer and Benary. The misplaced horizontal gray bar was not lighter, even though it had more black immediately surrounding it than the properly placed gray bar in the good A.

Our seventh series consisted of heavy and skeletal designs, such as a heavy black T with a critical gray in the corner and a "sketchy" T with a critical gray in the corner. According to the Gestalt theory, the critical gray outside of the heavy black figure should not be very much affected by it, but we found that it is.

Our eighth series consisted of figures with no background. Black figures were suspended against a black cloth. Here we found no results according to Wertheimer. Yet, we should have, if it is the configuration that produces this strange result.

There is evidently something here which has evaded our grasp. Certainly the analytical approach will not account for these results. But as we have seen, Wertheimer and Benary have not shown that is the configuration that accounts for them. But what this factor is, we do not know. Perhaps, if we might speculate, results are accounted for by something very much like what is called a configuration. It might be that when an enemy is discovered mingling with a group of friends, we interpret him in a very different light from what we would when we see him in isolation because of a dynamic system of relations in the brain which determines parts differently when caught up in its system. In other words, brain systems of dynamic relations might determine parts and not the parts the systems. Items grouped are given vastly different interpretations when isolated.

Spermatid Transformation in Anasa Tristis (De Geer)

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The junior author was assigned a study of the transformation of the spermatids into spermatozoa in living Anasa. He was not told that fixed material had been used for such a study of the squash bug. Thus this study became a test of just what can be seen in living material. After making the drawings and writing the descriptions the junior author compared his findings with those recorded in literature. Most of the observations are those of the junior author.

MATERIAL AND METHODS

The specimens were collected west of Kansas City, Kan., during November, 1935. The insects were kept in cages at the university during the winter, and thus living tissue was available at all times.

The parts to be examined were removed from the animal and placed on a thin cover slip with a small drop of Belar's nutrient solution. This cover slip was inverted over a hollow-ground slide and the edges of the cover slip were sealed with melted vaseline to prevent any evaporation of the nutrient solution. The mounts were studied with low and high-power objectives; and in some cases where great detail was necessary, the oil immersion was used. For the comparative study, material was fixed in Flemming's strong chromo-aceto-osmic fluids and stained with Heidenhain's iron hematoxylin.

MALE GENITAL SYSTEM OF ANASA

The testes of Anasa consists of two corn-shaped bodies which lie on the dorsolateral walls of the abdomen, extending from the second to the third abdominal segments. The anterior part of the testes is attached to the walls of the abdomen by delicate bands of connective tissue. The testes are covered with a fatty, reddish-orange connective tissue which adheres closely to each follicle. Careful dissection is necessary in order to remove this connective tissue in order to observe the complete follicles.

Each testis is composed of seven follicles, which lie in one plane. The length of the testis is 2 mm., and the width is 1.75 mm. at the distal end of the testics and tapers down to 1 mm. at the opposite end. The two lateral follicles are longer than the inner five, making the anterior end of the testis concave. The testes are well supplied with tracheal tubes.

The seven follicles are from 1.75 to 2 mm. long. The follicles are 0.25 mm. wide at the widest point and 0.14 mm. wide at the proximal end of the testes.

At the open end of the testis, the seven follicles connect with the vas deferens. The length of the vasa deferentia varies from 1 to 1.75 millimeters. The vas deferens is a very narrow tube which has a milky white appearance. It contains a number of muscle fibers which were constantly in motion. This contraction of the muscle fibers was seen to persist for four days in some of the living mounts.

REVIEW OF MEIOSIS AND SPERMATID FORMATION

At the beginning of the growth period, the primary spermatocytes contain 21 chromosomes. After a long, apparently inactive period the nuclear material condenses and forms spireme threads which later become 11 chromosomes. The arrangement of the choromosomes in the polar plate of the first and second spermatocyte division is characteristic. Nine of the chromosomes arrange themselves in a circle (fig. 1), with the tenth taking a central position; the eleventh, or accessory, chromosome is found near the periphery of the cell.

A number of timings on the division of the cells during the first maturation division showed that the length of the time from the metaphase to complete division into two cells is approximately 43 minutes. In the second spermatocyte division the chromosomes appear as short rods which vary slightly in size. They line up at the equatorial plate and split lengthwise and pass to each pole, a process which takes about 37 minutes (figs. 2 to 6). The chromosomes at the poles collect into a compact mass (fig. 6), losing all traces of their individual outlines. The accessory chromosome maintains its identity in some cases. During telophase stages, the chromosomes still appear as a compact, but more rounded mass. As successive stages develop this compact mass gradually breaks into granular clumps of various sizes and a nuclear wall forms (fig. 12). At the final stage of the nucleus the size has increased and the heavy granules have disappeared and only very small granules remain (fig. 19).

The accessory chromosome remains present during these stages although at some times it is not apparent. It is the last of the chromosomes to lose its solid appearance in the formation of the new nucleus.

THE NEBENKERN.—During anaphase of the second maturation division the mitochondria were found in the cytoplasm of the cell in the form of very short rods and granules, located close to the margin of the cell wall at about the point of constriction (fig. 5). As the division progresses, they unite and elongate until they appear as short fibers (fig. 6). During telophase, these short fibers begin to elongate until they extend from pole to pole (fig. 8). Each mitochondrium divides into approximately two equal halves during the division of the cell. As a result, one half of the entire mitochondrial substance as well as the interzonal fibers is given to each of the resulting spermatids (fig. 11).

After the separation of the cells the mitochondria and fiber mass gradually condense and shorten (figs. 12 to 14); the fibers then break into a string of granules (fig. 15); these round up and are surrounded by a wall (figs. 16 and 17). For a short time the granules gather around small vacuoles (fig. 18). This mass soon breaks and the granules are again scattered (fig. 19). This resulting body, which is found in the spermatid, is called the nebenkern.

THE ACROBLAST.—During the second spermatocyte division, the dictyosomes appear as small granules distributed in the Cytoplasm (fig. 4). At first they lie close to the cell wall outside the spindle fibers, but later they are found closely arranged between the mitochondrial and interzonal threads and the chromosome mass (figs. 5 to 8). At first the dictyosomes appear as small curved rods, but at the end of cell division they fuse and form a condensed mass which lies close to the wall of the nucleus (figs. 11 and 12). The clear

vesicle which usually characterizes the acroblast could not be clearly seen (figs. 14-18).

This condensed mass is at first not connected with the wall of the nucleus; but later, after the growth of the nucleus, it gradually comes in contact with it (fig. 18). At the beginning of spermiogenesis the dictyosome appears as a condensed mass of material associated with the wall of the nucleus. This mass of material later develops into the acroblast of the mature sperm.

SPERMIOGENESIS

The spermiogenesis of Anasa tristis has been carefully studied in living tissue. The characteristic structures, nucleus, nebenkern, acroblast, and axial filament of the spermatid will be described in detail.

THE NUCLEUS.—At the formation of the spermatid, the nucleus has attained its maximum size (fig. 19). From this stage on the nucleus gradually decreases in size until it appears to be about one third its original size (fig. 47). Later it begins to elongate, forming the head of the sperm (fig. 52). The chromatin material that appears in the nucleus at the beginning of spermatid transformation appears as very small granules scattered through the nuclear plasma (fig. 15). Later the granules begin to collect along the periphery of the nucleus. Very soon chromatin threads form which extend from the periphery into the clear central area of the nucleus (fig. 19). Still later the chromatin threads become more concentrated at the central area of the nucleus with a very few granules still scattered at the periphery of the nucleus (fig. 20). This condition does not last long, but the chromatin soon breaks into a vacuolated mass which is crisscrossed with very fine chromatin threads (fig. 21). Most of the chromatin granules are again found at the margin of the nucleus. From this stage of a weblike formation, the chromatin granules begin to condense and form two or three dark masses that are found in the center of the nucleus. The rest of the granules are scattered throughout the nucleoplasm. This stage remains for some time during the formation of the axial filament (fig. 22). But, again these dark masses disintegrate and form the weblike structure of cromatin threads (fig. 23). This stage lasts for the period during the attachment of the nebenkern to the axial filament. After this attachment some of the chromatin material again condenses to form the three large granules usually found in the center of the nucleus (fig. 25). The rest of the granules appear small and are still found next to the periphery of the nucleus. A few fiberlike attachments run from the small granules in the periphery to the three large granules in the center. This condition lasts until the acrosome has migrated almost around the nuclear wall (figs. 25 to 28). At the period when the acrosome begins to break up into small granules (fig. 29), there is likewise a breaking up of the three large granules that lie in the center of the nucleus. This disintegration of the large granules of the nucleus continues until nearly to the end of the formation of the head of the sperm. After the nucleus has reached its minimal size (fig. 47), there occurs a gradual elongation of the head. After the nucleus has taken on the appearance of a grain of wheat, the small granules of chromatin begin to concentrate on one side of the nucleus, leaving a small clear area on the opposite side (fig. 48). In the final stages of development, the chromatin material again begins to condense; first forming small threads (fig. 49), and later a solid

mass of chromatin material that completely fills the nucleus and is the final product of this transformation. This mass is one fourth of the total length of the mature sperm.

The Nebenkern.—During the formation of the axial filament and its elongation, the granular nebenkern approaches it and lies parallel to it (fig. 23). Later it divides; one half sheathing one side of the axial filament (fig. 23), and the other half the other side. There is no great change in the chondriosome granules of the nebenkern for the rest of the transformation with one exception. For a while the granules elongate and form threadlike structures in the nebenkern remaining inside the nucleus (figs. 29 to 32). After the sheathing both sheathing and filament gradually elongate while the part of the nebenkern in the nucleus gradually decreases in size and length as more protoplasmic material is passed down as "blebs" (fig. 31 to 47). Finally the nebenkern disappears entirely forming the sheath for the tail (fig. 52).

The Acroblast and the Acrosome.—This condensed material, the acroblast, migrates almost around the nucleus along its wall (figs 19 to 28), and comes to rest on the opposite side. In this position, the dark mass gradually breaks until a circular ring is formed with two points of attachment (fig. 29). There is a very small vacuole formed at this time, with the granules taking a peripheral position (fig. 30). The granules soon scatter and fill the entire circle. The two points of attachment of the acroblast at first draw gradually together forming one common attachment (fig. 30). The vacuole is largest during this period. With the disappearance of the vacuole, the common attachment becomes two and the acrosome moves toward the anterior end of the cell (figs. 31 to 33), where it forms a crescent-shaped structure over the tip of the nucleus. The fine granules are gradually transformed into a very dark cap (fig. 36), which retains a crescent-shape until the beginning of the elongation of the nucleus. As the nucleus elongates, there occurs a gradual tapering of the acroblast so as to form a very sharp point (fig. 42). This point remains straight until the beginning of the condensed state of the nucleus, when it gradually bends toward the side on which the clear area in the nucleus is located (fig. 48). Its final shape has the appearance of a flat point bent at an angle of about 45 degrees (fig. 52).

The Centrioles and the Axial Filament.—After the separation of the two daughter cells in the last maturation division, the centriole appears on the side of the spermatid opposite the mitochondrial mass (fig. 11). The centriole migrates part way around the wall of the nucleus until it lies in a position about half way down the side of the nuclear wall (figs. 19 to 21). In this position, it becomes associated with the wall of the nucleus. Then the small thread of the axial filament forms. The axial filament is sheathed by the nebenkern and both gradually elongate (figs. 23 to 52), until finally the tail is a very thin thread about three times the length of the head (fig. 52). The centriole becomes a short, thick rod which fuses with the wall of the nucleus and forms the middle piece of the mature spermatozoon. There is no noticeable difference in the density of the nucleus and the middle piece at this period.

Movement of the Sperm.—In freshly moulted adults we find the mature sperms aggregated into very compact bundles about two thirds of the way down from the distal end of the follicle. The wall of the bundle soon breaks,

setting free the living individual sperms in the upper third of the follicle. They swim in no definite direction, but finally make their way out into the vas deferens. This movement of the sperms into the vas deferens causes the milky-white coloration in the latter.

The movement of the tail of the sperms proves to be very interesting. When very lively a sperm will whip its tail rapidly, making a series of "S" like movements. If the sperm is in a clear field, this movement is very narrow; but if the field is filled with other sperms and protoplasmic material, this movement begins to take a larger sweep. As the sperm gradually slows down, the whip of the tail becomes very broad. Later sometimes only slight tremors pass down the tail. At the death of a sperm, the tail coils. Sometimes the tail curls and remains in that position for a short while; but if it comes into contact with another sperm or irritant, the tail will start moving again. This may be interpreted as a rest period through which some of the sperms pass.

The sperm has a peculiar manner of penetration into any object. The hook is bent at an angle of 45 degrees, so when the sperm penetrates into a mass of protoplasm, the point is pushed in first and then the sperm bends its head so that it hooks itself into this mass from which it is unable to break loose. After the head has penetrated into some bit of protoplasm, the tail shows vigorous motion pushing this mass around through the nutrient solution. The sperms that have penetrated a bit of protoplasm remain alive much longer than the sperms that remain free in the same locality. We were able to keep some sperm alive for 96 hours.

THE FORMATION OF THE CYSTS

The formation of the cysts begins at the distal end of the follicle. There occur two or three spermatogonial cells separated from other cells by very thin bands of fibrous connectve tissue which branch out from the walls of the follicle. These fibers are first connected with each other. Later, as traced further up the follicle, the connective tissue fibers take a more definite shape. They form small cysts around a group of cells. About one fourth of the way up the follicle the fibers form individual cysts, each separated from the other. In this region occur the multiplication and growth stages of the cell. As the cells increase in size, the cyst does likewise. The cyst remains in a circular shape during the first and second maturation divisions, and the cells increase in number till they reach about 256. With the elongation of the spermatid, there is also the elongation of the cyst until it takes on the shape of a cigar.

The spermatids are crowded very closely together, at the beginning of spermiogenesis, and they have no definite arrangement in the cyst. During early elongation of the tail, the cyst is full of disorderly arranged sperm heads and tails. When the nucleus is at its minimum size, we find the sperm heads collecting in one part of the cyst and the tails curling back from the heads. With the gradual elongation of the cyst, there comes the gradual unwinding of the sperms from their tangled mass. The movements of the head and tail of a sperm do not always take place at the same time. Some of the sperm heads still resemble a grain of wheat while others have reached the final stage.

The heads have an appearance of being embedded in the cyst wall and the elongating of the cyst permits the sperms to straighten out. The cyst wall during this period is still very thin, but later becomes quite thick, and is filled with a large number of protoplasmic vesicles. These vesicles are the "blebs" which have been cast off from the tails of the sperm.

The release of the sperms from the cysts takes place in the upper third of the follicle. The breaking of the wall of the cyst does not take place in any definite part. Sometimes the wall will break at the head and setting free the heads of the sperm and still leaving the tails embedded, while in other cases the wall will break at the tail end of the cyst. After the cyst wall has broken, the wall peels off, gradually breaking into small bits of protoplasmic material which are cast off into the fluid of the follicle setting free the living individual sperms.

This study of formation and metamorphosis of the spermatid of *Anasa tristis* was completed by the junior author before he read any of the literature concerned.

DISCUSSION

The Nucleus

The metamorphosis of the spermatid in Anasa as we have found it differs in some details from that described by F. C. Paulmier (*7*) in fixed tissue, however, in many details it confirms his findings. It further confirms the observations upon the arrangement of the chromosomes made by Paulmier (*7*), Wilson (*8*), Montgomery (*5*), Foot and Strobell (*3*) by photomicrographs and Baumgartner (*1*) photomicrographs of living cells.

Working with living tissues gave us certain advantages over the older workers, and also certain disadvantages. The stained material shows more of the granules in the nucleus, but the living cells permit us to follow the changes from time to time. See our description of nuclear changes. Paulmier (*7*) saw the massing of the chromatin on one side of the forming sperm head. This is confirmed by the photomicrographs taken by Baumgartner (*1*).

The Nebenkern

The formation and transformation of the nebenkern evidently vary a great deal. Paulmier (*7*) states that the nebenkern appears to be formed from the yolk granules and the remains of the spindle fibers. The granules, located around the nucleus of the cell during division, move down to lie close to the nuclear wall and the spindle fibers. The granules along with some of the spindle fibers soon form a bundle with a number of long vacuoles appearing in it. The long vacuoles soon break into a series of small vacuoles which he calls the "blackberry" stage. This soon disappears and the nebenkern assumes a bilateral form.

The formation of the nebenkern has been described by many workers. We cite only a few. Sabatier in 1890 observed the nebenkern in the Tettigoniidae arising from the protoplasm. Erlanger in 1896 discussed the nebenkern in the spermatids of insects, and uses this term to describe a body formed by the remains of the connecting fibers, and taking part in the formation of the tail. Otte (*6*) describes the nebenkern as being formed by a portion of the mitochondria which were found in each cell during division. The mitochondria condense and form the compact nebenkern. Bowen (*2*) describes the neben-

kern as being formed from the chondriosomes and having a large number of vacuoles in the periphery of the mitochondrial mass.

Our observations on the formation of the nebenkern in the living tissues agree with those of Otte and Bowen. Paulmier apparently failed to see the appearance of heavy fibers in the nebenkern during the migration of the acrosome around the nucleus.

The Acrosome

The formation of the acrosome differs greatly in the two descriptions. Paulmier states that the acrosome arises as a bud from a portion of the nebenkern mass, and remains in that position for a while before elongating to the anterior part of the nucleus where it condenses to form the cap of the sperm. In our own material no such movement of the acrosome to the anterior side of the nucleus, and then back again, occurs. At one stage of the acrosome transformation a constriction appears across it separating the vacuolated end from the fixed homogeneous end. This vacuolated end breaks loose and moves down into the cytoplasm, losing its vacuole and shrinking into an irregular mass. No mention was made by Paulmier of the formation of a hook of the acrosome at the head end of the sperm.

Otte (*6*) gives an account of the formation of the acrosome in Locusta. He states that the acrosome arises from the idiosome, the fibers of which are first found in the mitochondria.

Bowen (*2*) in his study of the Hemiptera describes the acroblast complex as originating from the dictyosomes through fusion.

Johnson (*4*) in his study of Oecanthus states that the acroblast is produced by the fusion of a number of dictyosomes, from which the acrosome is apparently differentiated.

Our study of the acrosome and acroblast shows that in our species it is formed from a mass of dictyosomal material at first lying close to the cell wall outside the spindle fibers with the mitochondria. Later they move to the clear space between the nuclear plate and mitochondrial threads, fusing and forming a solid dictyosomal mass which later fuses with the nuclear wall. A definite migration of the acrosome around the wall of the nucleus has been noted. The sloughing off of the vacuole was not noticed at this time as Paulmier found in his material. The formation of the point of the sperm was the same in both cases, although no mention is made by Paulmier of the bending of the point in the direction of the vacuole within the nucleus.

The Centrosome and Axial Filament

Paulmier was unable to observe the movement of the centrosome through all the stages. After the division of the cell, the centrosome disappeared and did not make its reappearance until it was found within the nebenkern, at which time the axial filament also appeared.

In the living tissue the centrosome has been seen in almost all cases. After the division of the two cells the centrosome gradually moves from its dorsal position about half way down the nuclear wall. It becomes attached to the wall of the nucleus, and an axial filament makes its appearance. The centrosome then migrates to the base of the nucleus and during the final stages it moves into the middle part of the mature sperm.

SUMMARY

1. The primary spermatocyte contains the diploid number (21) of chromosomes. The reduction division takes place during the first division.

2. The chromosomes have a characteristic arrangement since nine of the chromosomes arrange themselves in a circle, while a tenth takes a central position; the eleventh is found at the periphery of the cell.

3. The mitochondral substance arises from small granules and rods found close to the periphery of the cell. The granules elongate forming a cigar-shaped mass which soon rounds up and forms the nebenkern. The nebenkern after undergoing many changes elongates and becomes part of the tail of the sperm.

4. The acroblast first makes its appearance as small dictyosome granules in the cystoplasm, which soon collect and fuse, forming the acroblast. Migration then takes place from one side of the nucleus to the other and then back to the anterior part of the nucleus, where the acroblast becomes the point of the sperm.

5. The centrosome has been followed through nearly all of its migrations. It becomes attached to the wall of the nucleus about one-half way down the side. The axial filament grows out and then the centrosome is found at its base on the nucleus. The centrosome forms the middle part of the sperm and the axial filament, along with the nebenkern, forms the tail.

6. The mature spermatozoon consists of a small hook bent about forty-five degrees in relation to the head. The head is quite long making up one fourth of the length of the entire sperm.

7. The movement of the sperm involves an "S' like motion of the tail. The sperm remained alive as long as ninety-six hours in a nutrient solution.

8. The cyst is formed by connective tissue fibers from the walls of the follicle; it has no definite place of breaking.

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PLATE I

(All figures were drawn from the living tissue)

ANASA TRISTIS (De Geer)

FIG. 1. Shows the chromosomes in their characteristic circular arrangement.

FIGS. 2 TO 6. Division of a single cell from metaphase to anaphase. Showing mitochondrial threads, also small dictyosomes.

FIGS. 7 TO 11. Division of a single cell from anaphase to two spermatids.

FIG. 7. Dictyosomes collecting in the clear area between the chromatin mass and the spindle fibers.

FIGS. 8 TO 10. Mitochondrial fibers fusing and increasing in length.

FIGS. 11 TO 13. Dictyosomes collecting and condensation has started. Nuclear wall being formed.

FIG. 14. Mitochondrial fibers have formed an elongated mass.

FIG. 15. Long granular stage of the nebenkern.

FIGS. 16 TO 17. Fusion of dictyosomes into one mass.

FIG. 18. "Blackberry" stage of nebenkern. Dictyosomes have fused with the nuclear wall.

FIGS. 19 TO 21. Migration of centrosome part way down the nuclear wall.

FIG. 22. Beginning of the formation of the axial filament.

FIGS. 23 AND 24. Sheathing of axial filament by the nebenkern and elongation of both—lower end cut off.

PLATE I

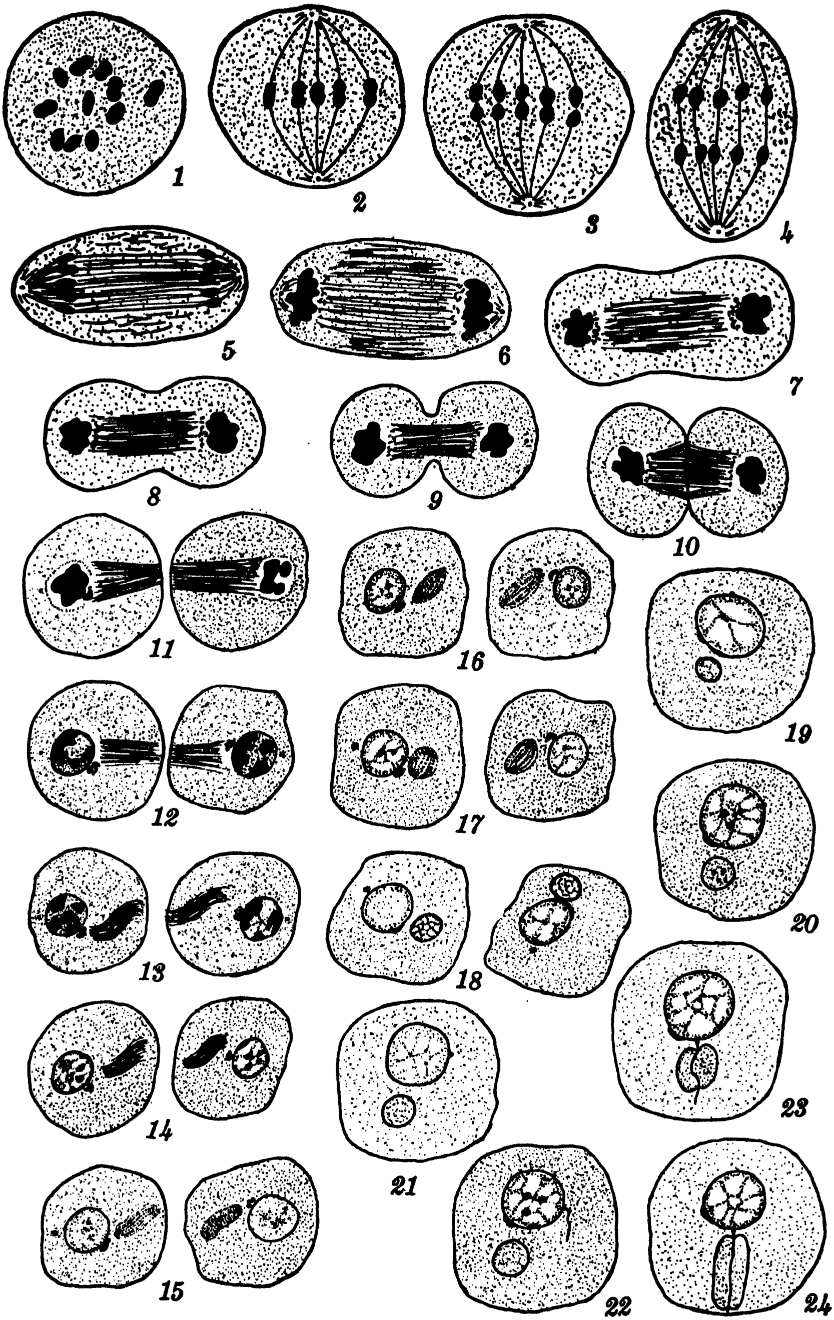


PLATE II

FIGS. 25 TO 28. Migration of the acrosome around the nucleus.

FIG. 29. Diffuse stage of acrosome.

FIGS. 29 TO 32. Large rods found in the nebenkern.

FIG. 30. Vacuole stage of the acrosome.

FIGS. 31 TO 35. Migration of the acrosome back to the anterior end of the nucleus.

FIG. 36. Condensed stage of the acrosome.

FIGS 37 TO 46. Formation of the point of the sperm by the acrosome.

FIGS. 40 TO 45. Casting off of the protoplasm of the cell leaving the free nucleus.

FIG. 45. Minimum size of the nucleus.

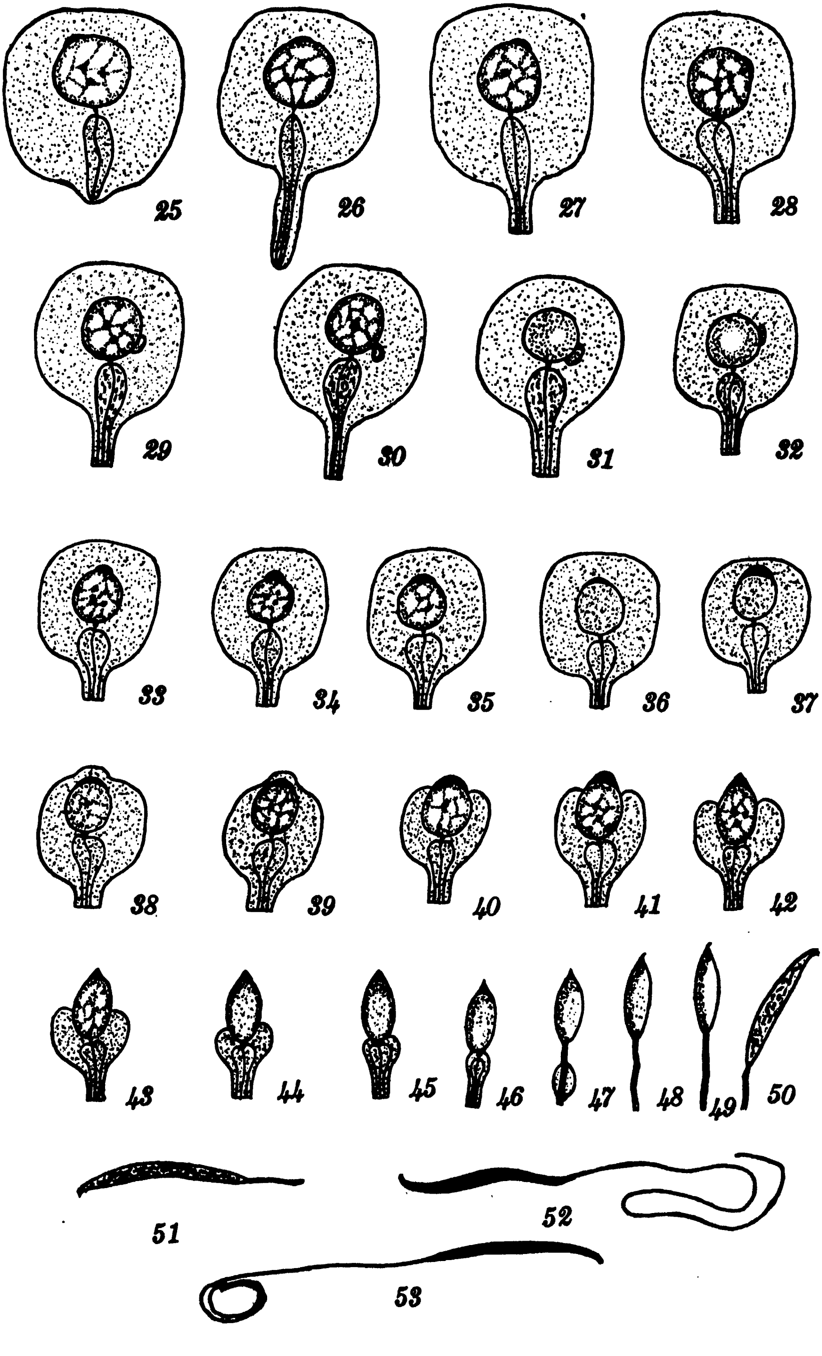
FIGS 46 TO 49. Formation of the vacuole in the nucleus. Bending of the point toward the vacuolated side.

FIGS. 49 TO 52. Elongation of the nucleus. Condensing of the chromatin material to form the solid head.

FIG. 52. The mature spermatozoon.

FIG. 53. Sperm in a resting or "dead" position.

PLATE II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A Study of the Habitat of the Reptiles and Amphibians[1] of Ellis County, Kansas

L. A. BRENNAN, Andale, Kan.

Ellis county is only a short distance west and north of the center of Kansas. It lies between the 99th and 100th meridians at the eastern margin of the High Plains. The surface of the county is of the same character as that of most of Western Kansas, one vast stretch of plains, almost completely destitute of trees, excepting for a narrow portion along the principal streams, and here and there near a farm house. The surface of the county, however, is very far from being uniform. Some portions, especially the southeastern, are quite level; the central portion is very high and uneven; while in the western and northern portions, especially in the vicinity of the Saline river, there are a number of bluffs.

The county is drained by the Saline river, which runs from west to east along the northern boundary of the county, and the Smoky Hill river which runs in the same direction close to the southern boundary. Big creek traverses the county diagonally, midway between the Saline and the Smoky Hill rivers.

The rocks exposed in Ellis county are of the Cretaceous system, excepting the sands and gravels along the rivers, which are of a much later period (Pleistocene). The two great divisions of the Cretaceous, the Benton and the Niobrara group, cover the whole area.

The upper member of the Niobrara group, the Smoky Hill chalk, does not cover much area in Ellis county. The Fort Hays limestone covers approximately the western half of the county, being exposed on the hills. The rock is a yellowish limestone, which is easily dressed and has been used locally as building stone. Just below the Fort Hays limestone are shales of great thickness, which contain large calcareous concretions.

The upper Benton portions are called the Blue Hill shales and are exposed in the hills west and northeast of Hays. The lower Benton group contains more limestone than the upper division. It is exposed in the eastern part of the county and is known as the Benton limestone, locally called "fence post."

The soils of Ellis county have been formed from limestone, sandstone, and shale, with limestone predominating in most of the area. The soil along the streams of the region is predominately sandy and sand pockets are found along the streams throughout the county.

The plant life of Ellis county is characaterized as a mixed prairie association. It is a combination of tall and short grass areas.

DESCRIPTION OF HABITATS

Ellis county affords a choice of several habitats for the animals found in it. For the purpose of logical consideration of the amphibian and reptilian fauna, the habitats of this region will be discussed under two main headings:

I. Terrestrial:
   1. Mixed prairie
   2. Flat Rock Hillsides
   3. Rocky Hillsides

1. Brennan, L. A. A check list of Reptiles and Amphibians of Ellis county, Kansas. Transactions of Kansas Academy of Science 37:189-191, 1934.

II. Aquatic:
1. Stream
2. Swamp
3. Permanent Mixed Prairie Pond
4. Temporary Mixed Prairie Pond

There is variation among the species as to their habitat distribution, some being exclusive to one while others are scattered.

The biota of most areas is constantly undergoing change. Environment plays a large part in the general distribution of animals, and if the physiography of the present area changes, the fauna that it supports will very probably undergo modification and redistribution.

1. Mixed Prairie Habitat

Under natural conditions the tops and slopes of the hills of Ellis county support a climax association of thick prairie vegetation. Only a few spots remain which show the original conditions. The fact that the open, rolling country affords excellent opportunities for farming, has caused the greater portion of the area to be put under cultivation. At their best grasses and sedges cover the ground and grow to a height of almost a foot. Among the important species of grasses in this mixed prairie habitat are: the short grasses; buffalo (*Buchloe dactyloides*), and grama (*Bouteloua gracilis*); the tall grasses: big bluestem (*Andropogon furcatus*), and little bluestem (*Andropogon scoparius*), the latter being dominant. The hills and the outcroppings of limestone make it difficult to cultivate the rougher parts, and here there is still an abundant growth of prairie grasses.

2. Flat-Rock Hillside Habitat

The slopes of hills in this habitat are covered with flat rocks of various shapes and sizes, most of which vary from three to eight inches in thickness. These rocks are outcroppings of Benton limestone. Many are large, eight or ten feet across, sometimes imbedded in the ground. These flat stones make an excellent shelter for animals. The dominant plant in this habitat is the little bluestem.

3. Rocky Hillside Habitat

This habitat consists of an outcropping of Fort Hays limestone. The rocks are sometimes very large and they may be as much as ten feet thick. This is in contrast to the flat rocks of the Benton formation. Fort Hays limestone tends to disintegrate much faster than Benton limestone, so the ground is often covered with small portions of these rocks.

4. Stream Habitat

The streams of Ellis county, namely, Big creek, Smoky Hill river, and the Saline river have been grouped together and classified as a stream habitat. Big creek crosses the county in a southeasterly direction about midway between the Smoky Hill and Saline rivers. This stream is fed by springs, and dams are being built at various places. The Smoky Hill river, which flows from west to east in the southern portion of the county, has a sandy bed that is rarely more than a few hundred feet in width. The Saline river flows in the same direction as the Smoky Hill river, but is located in the northern portion of the county. It is a narrow and shallow river, with occasional pools,

rarely more than five feet deep. All through Ellis county it is situated between rocky bluffs sometimes sixty feet in height.

These streams are all sandy, though Big creek has less sandy areas than the two rivers. The two rivers are very likely to go dry during a very dry season, but Big creek, due to springs, always manages to hold its own. Big creek went out of its banks in Ellis county in 1932 and caused considerable damage to property in the city of Hays. All of these streams are well lined with trees, among them the American elm, boxelder, hackberry, cottonwood, honey locust, ash, mulberry, willows, and cedars, the cedars being prominent along portions of the Saline river. Intermingled with the trees are such shrubs as the sumac, the wild plum, the wild grape and the wild cherry.

5. Swamp Habitat

The soil of the swamp is supersaturated with moisture throughout the year. Here half disintegrated plant fragments accumulate and continue for a longer or shorter time unchanged. These decompose to form a black, oozy, odoriferous muck. Algae of many kinds are found here. The "blanket algae," whose dense felt mats may smother many submerged animals, is common. The arrowhead and the water plantain are also very common here.

6. Permanent Mixed Prairie Pond Habitat

Many artificial ponds have been built in both the prairie and hilly pasture areas. The permanent ponds are fed by springs. These ponds are bordered by the characteristic short grasses, namely, buffalo and grama, while the water is often covered with algae.

7. Temporary Mixed Prairie Pond Habitat

The temporary prairie ponds are generally slight depressions in the surface of the short grass pasture land or in gullies and draws. These ponds are fed by flood waters and often go dry in periods of drought.

Relationship Between Species and Habitat

1. *Mixed Prairie Habitat*

Of the thirty-nine species of amphibians and reptiles reported here, twenty-one are found in this habitat, namely, four amphibians, four lizards, one turtle and twelve snakes. Eleven species reach their maximum abundance here: box tortoise, race-runner, common horned lizard, Woodhouse's toad, western toad, spadefoot, bull snake, blue racer, rattlesnake, hog-nosed snakes (light and dark). The hog-nosed snakes are exclusive to this area and there are more species of amphibians and reptiles found here than in any other habitat.

2. *Flat-Rock Hillside Habitat*

Fifteen species are found in this habitat: one amphibian, five lizards, and nine snakes. Eight species of reptiles reach their maximum abundance here. They are: collared lizard, Sonoran skink, rat snake, prairie spiny lizard, earless spotted lizard, ring-necked snake and Say's kingsnake. Three reptiles are exclusive to this habitat: collared lizard, Sonoran skink and the rat snake, and lizards are more numerous here than in any other. That flat rocks of the Benton formation afford more shelter than the rocks of the Fort Hays lime-

stone is evidenced by the greater number of individuals collected in the flat-rock areas.

3. *Rocky Hillside Habitat*

Thirteen species are found in this habitat: two amphibians, three lizards, seven snakes and one turtle. Two reach their maximum abundance here, the narrow-mouthed toad and the lined snake. The narrow-mouthed toad is also exclusive to this habitat.

4. *Stream Habitat*

Thirteen species occur here, being divided as follows: four amphibians, five snakes and four turtles. There are more amphibians in the stream habitat than in any other. This is natural for the amphibians must have water in which to deposit their eggs. Four amphibians were not observed in the stream habitat (narrow-mouthed toad, western toad, Woodhouse's toad, and the spadefoot), probably due to the vicissitudes of collecting. One snake (ribbon snake) and one turtle (soft-shelled) reached their maximum abundance here.

5. *Swamp Habitat*

Comparatively, this semiaquatic habitat harbors the smallest number of species. Seven are found as follows: two turtles, two snakes and three amphibians. None reach their maximum abundance in nor are exclusive to this habitat.

6. *Permanent Mixed Prairie Pond Habitat*

Ten species are found here: three amphibians, three snakes and four turtles. Turtles are represented here by more species than in any other habitat, for only permanent ponds furnish the aquatic types a home throughout the year. Six species reach their maximum abundance here. They are as follows: mud turtle, Bell's terrapin, snapping turtle, leopard frog, cricket frog and the bullfrog. The bullfrog (*Rana catesbeiana*) was found in the permanent ponds and not in the temporary ponds. Evidently it requires a habitat that contains water all the year around. The mud turtle is found in the Smoky Hill river in the southern part of the county. A specimen is reported from the Saline river by L. D. Wooster. None has been observed in Big Creek.

7. *Temporary Mixed Prairie Pond Habitat*

Eight species are found here: four snakes, one turtle and three amphibians. The tiger salamander reaches its maximum abundance in this habitat. Many larvae are found in the ponds of this terrain.

TABLE I

HABITAT DISTRIBUTION OF AMPHIBIA

NAME.	Mixed prairie.	Temporary mixed prairie pond.	Permanent mixed prairie pond.	Stream.	Swamp.	Flat rock hillside.	Rocky hillside.
Leopard frog	24	391	1,450	462	45		10
Cricket frog		12	1,543	165	120		
Bullfrog			241	42	1		
Salamander		20		2			
Narrow-mouth toad						1	2
Woodhouse's toad	150						
Western toad	2						
Spadefoot	1						

HABITAT DISTRIBUTION OF SNAKES

NAME.	Mixed prairie.	Temporary mixed prairie pond.	Permanent mixed prairie pond.	Stream.	Swamp.	Flat rock hillside.	Rocky hillside.
Bull snake	20	1	1	1		3	7
Lined snake						1	2
Ribbon snake		1		2			
Garter snake	1	10	20	6	6		
Water snake		12	30	18	4		
Coachwhip	1						1
Blue racer	16			1		3	1
Ring-necked						14	
Hog-nosed (light)	2						
Hog-nosed (dark)	1						
Rattlesnake	10					2	2
Rat snake	5					48	
Salt and pepper snake	1					3	1
Banded king snake	1					3	
Mitre snake	1					6	1

HABITAT DISTRIBUTION OF LIZARDS

NAME.	Mixed prairie.	Temporary mixed prairie pond.	Permanent mixed prairie pond.	Stream.	Swamp.	Flat rock hillside.	Rocky hillside.
Collared lizard						49	
Skink (Sonoran)						26	
Prairie spiny lizard	10					63	5
Earless Spotted lizard	6					8	
Six-lined lizard	40					3	7
Horned lizard	9						1

HABITAT DISTRIBUTION OF TURTLES

NAME.	Mixed prairie.	Temporary mixed prairie pond.	Permanent mixed prairie pond.	Stream.	Swamp.	Flat rock hillside.	Rocky hillside.
Mud turtle			11		4		
Box tortoise	32		3	30			2
Bell's terrapin			118	4			
Snapping turtle			68	37			
Soft-shelled turtle				8			

Number of Species Found in Each Habitat

The figures after the names in the following lists of species of amphibians and reptiles indicate the numbers of individuals collected or positively identified in the different habitats during 1931-1933.

1. The Mixed Prairie Habitat:

Rana pipiens. Leopard frog	24
Bufo cognatus. Western toad	2
Bufo woodhousii. Woodhouse's toad	150
Pituophis sayi sayi. Bull snake	20
Tantilla gracilis nigriceps. Mitre snake	1
Thamnophis radix radix. Garter snake	1
Crotalus viridis viridis. Rattlesnake	10
Coluber constrictor flaviventris. Blue racer	16
Heterodon nasicus. Hog-nosed snake	1
Lampropeltis triangulum gentilis. Banded king snake	1
Lampropeltis getulus holbrookià. Salt and pepper snake	1
Masticophis flagellum flagellum. Coachwhip snake	1
Terrapene ornata. Box tortoise	32
Cnemidophorus sexlineatus sexlineatus. Race runner	40
Holbrookia maculata maculata. Earless spotted lizard	6
Sceloporus undulatus consobrinus. Prairie spiny lizard	10
Phrynosoma cornatum. Common horned lizard	9

2. The Flat Rock Hillside Habitat:

Microhyla olivacea. Narrow-mouthed toad	1
Crotaphytus collaris. Collared lizard	49
Eumeces obsoletus. Sonoran skink	26
Sceloporus undulatus consobrinus. Prairie spiny lizard	63
Holbrookia maculata maculata. Earless spotted lizard	8
Cnemidophorus sexlineatus sexlineatus. Race runner	3
Phrynosoma cornatum. Horned lizard	9
Pituophis sayi sayi. Bull snake	3
Tantilla gracilis nigriceps. Mitre snake	6
Thamnophis lineatus. Lined snake	1
Coluber constrictor flaviventris. Blue racer	3
Diadophis punctatus arnyi. Ring-necked snake	14
Crotalus viridis viridis. Rattlesnake	2
Elaphe laeta. Rat snake	48
Lampropeltis getulus holbrookia. Salt and pepper snake	3
Lampropeltis triangulum gentilis. Banded king snake	8

3. The Rocky Hillside Habitat:

Microhyla olivacea. Narrow-mouthed toad	2
Rana pipiens. Leopard frog	10
Sceloporus undulatus consobrinus. Prairie spiny lizard	5
Cnemidophorus sexlineatus sexlineatus. Race runner	7
Phrynosoma cornutum. Horned lizard	1
Terrapene ornata. Box tortoise	2
Pituophis sayi sayi. Bull snake	7
Tantilla gracilis nigriceps. Mitre snake	1
Thamnophis lineatus. Lined snake	2
Masticophis flagellum flagellum. Coachwhip	1
Coluber constrictor flaviventris. Blue racer	1
Crotalus viridis viridis. Rattlesnake	2
Lampropeltis getulus holbrooki. Salt and pepper snake	1

4. The Stream Habitat:

Ambystoma tigrinum. Tiger salamander	2
Rana catesbeiana. Bullfrog	42
Acris gryllis. Cricket frog	165
Rana pipiens. Leopard frog	465

Terrapene ornata. Box tortoise	30
Chelydra serpentina. Snapping turtle	31
Amyda spinifera. Soft-shelled turtle	8
Chrysemys bellii bellii. Bell's terrapin	4
Pituophis sayi sayi. Bull snake	1
Natrix sipedon sipedon. Brown water snake	18
Thamnophis radix radix. Garter snake	6
Coluber constrictor flaviventris. Blue racer	1

5. The Swamp Habitat:

Thamnophis radix radix. Garter snake	6
Natrix sipedon sipedon. Brown water snake	4
Chelydra serpentina. Snapping turtle	3
Kinosternon flavescens. Mud turtle	4
Acris gryllus. Cricket frog	120
Rana pipiens. Leopard frog	45
Rana catesbeiana. Bullfrog	1

6. The Permanent Prairie Pond Habitat:

Rana pipiens. Leopard frog	1,450
Acris gryllus. Cricket frog	1,548
Rana catesbeiana. Bullfrog	241
Kinosternon flavescens. Mud turtle	11
Terrapene ornata. Box tortoise	3
Chrysemys bellii bellii. Bell's terrapin	118
Chelydra serpentina. Snapping turtle	68
Pituophis sayi sayi. Bull snake	1
Thamnophis radix radix. Garter snake	20
Natrix sipedon sipedon. Brown water snake	30

7. Temporary Mixed-Prairie Pond Habitat:

Rana pipiens. Leopard frog	391
Acris gryllus. Cricket frog	12
Ambystoma tigrinum. Tiger salamander	20
Pituophis sayi sayi. Bull snake	1
Thamnophis sauritus proximus. Ribbon snake	1
Thamnophis radix radix. Garter snake	10
Natrix sipedon sipedon. Brown water snake	12
Chrysemys bellii bellii. Bell's terrapin	8

The Lizards of the Southeastern United States

CHARLES E. BURT, Southwestern College, Winfield, Kan.

INTRODUCTION

This present article is the first of a series of contributions to the knowledge of the amphibians and reptiles of the southeastern United States (including the states of Florida, Georgia, Alabama, Mississippi, Tennessee, North Carolina and South Carolina). A survey of the literature shows that, with the exception of several studies of genera or families,[1] no comprehensive treatment has been given to the herpetology of this area since the appearance of Cope's monograph on the "Batrachia of North America" in 1889 and his monumental treatise on the "Crocodilians, Lizards and Snakes of North America" in 1900, and no paper, or series of papers, has been devoted exclusively to this subject. Indeed, even modern state lists are mostly in abeyance from this region,[2] which remains as little explored as any section of like size in the United States.

The present survey is the result of a coöperative agreement with the Smithsonian Institution, which was entered into through the kindness of Dr. Alexander Wetmore, assistant secretary. Through this arrangement financial support was advanced during the summers of 1932, 1933 and 1934, and all specimens obtained (with the exception of a few duplicates) are now entered into the collection of the United States National Museum. The report on the turtles is reserved for a forthcoming conograph of that group by Dr. Lenhard Stejneger, curator of herpetology, but the data on all of the other amphibians and reptiles will appear in the present series. In addition to the newly gathered field material, all of the southeastern specimens in the national collection have been studied through the courtesy of Doctor Stejneger and Dr. Doris M. Cochran. Special permission to collect in their respective states (including permission to seine in most cases) was granted to me through Doctor Wetmore by the following persons: Commissioner I. T. Quinn, Department of Game and Fisheries, Alabama (March 24, 1933); Peter S. Twitty, Department of Game and Fish, Georgia (March 20, 1933); Assistant Director J. S. Hargett, Department of Conservation and Development, North Carolina (June 28, 1932); State Game Warden Howell Buntin, Department of Game and Fish, Tennessee (June 27, 1932); and State Director of Conservation Hunter Kimball, Mississippi (June 11, 1934).

The friends that aided me in the field upon special occasions are: Dr. A. S. Pearse, Dr. I. E. Gary and Miss Anne Gardiner of Duke University; Dr. E. B. Powers of the University of Tennessee, and Dr. J. Beard, acting director of the Highlands Biological Station in 1932; and various game wardens on the staff of Hunter Kimball (Miss.) in 1934. Doctor Gray has very generously presented the United States National Museum with a valuable personal col-

1. Such as Ruthven's consideration of the garter snakes, Blanchard's revision of the king snakes, Ortenburger's review of the whip snakes and racers, Dunn's analysis of the salamanders of the family Plethodontidae, my phylogenetic study of the lizards of the genus *Cnemidophorus*, and Taylor's recent survey of the lizards of the genus *Eumeces*.

2. Not overlooking the valuable work of Brimley in North Carolina, and of Löding and Haltom in Alabama.

lection of amphibians and reptiles from North Carolina, and an excellent herpetological series from South Carolina was obtained from Miss Flora Brodie, of Leesville. Additional records have been secured from Doctor Powers, and from Prof. J. E. Ives of Carson and Newman College. Mr. Luther Hoyle and Mr. Cornelius Rogers served as field assistants in Mississippi in 1934. To all of these I am deeply grateful.

Besides the collectors indicated above, numerous individuals have contributed southeastern amphibians and reptiles to the National Collection.[8] Locality records are listed alphabetically by counties in the following pages.

This primary presentation is confined to the lizards, of which eighteen forms occur in the Southeast. These may be distinguished by the following key:

Key to the Lizards of the Southeastern United States

PAGE

1. Legs present 3
1. Legs absent 2
2. Ear opening distinct. Joint-lizard, or "Glass-snake"..........*Ophisaurus ventralis*, 364
2. Ear opening concealed or absent. Florida Worm Lizard.........*Rhineura floridana*, 364
3. Body with less than six prominent longitudinal light stripes, or with none at all... 4
3. Body with six or more well developed longitudinal yellow stripes. Six-lined Race-runner, or Sand-lapper..................*Cnemidophorus sexlineatus sexlineatus*, 356
4. Limbs completely developed; digits normally five, with or without distil expansions or pads 5
4. Limbs vestigial, extremely minute, and with only one or two digits; body elongate, cylindrical. Florida Burrowing Skink.......................*Neoseps reynolsi*, 368
5. Digits normal, tapering or of even width from base toward tip.................. 10
5. Digits extensively dilated or expanded away from base, especially at or near tip, 6
6. Eyelids not developed, eye exposed or set in a rounded capsule; tail thickened, fragile, often constricted at base; no throat fan; skin soft. Geckos................. 8
6. Eyelids developed, both above and below eye; tail slender, tapering, not particularly fragile, and not constricted at base; throat-fan often discernable; skin relatively tough. Anoles, or "Chameleons".. 7
7. Tail rounded; body and tail without a median dorsal ridge or keel. American "Chameleon"..*Anolis carolinensis*, 352
7. Tail strongly compressed from sides, with a median dorsal ridge which extends forward on the back; tail with rings of larger scales separated by alternate belts of smaller ones. Ring-tailed "Chameleon" (Key West)..........*Anolis stejnegeri*, 353
8. Maximum digital expansion at tip of digit where large digital pads are found.... 9
8. Maximum digital expansion not at tip of digit; terminal digital pads absent. Introduced European Gecko (Key West)..................*Hemidactylus turcicus*, 351
9. Scales on back larger, flattened, overlapping, usually with median longitudinal keels. Reef Gecko (southern Florida and perhaps southern Alabama) ....*Sphaerodactylus notatus*, 352
9. Scales on back small, granular or beaded, not overlapping, smooth. Introduced Greater Antillean Gecko. (Key West)................*Sphaerodactylus cinereus*, 352

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8. In the following distributional lists, collectors are indicated by their last names only. Those involved may be listed alphabetically as follows: H. A. Allard, R. W. Anderson, Vernon Bailey, W. H. Ball, Mr. Banks, H. S. Barber, Thomas Barbour, C. M. Barrett, Paul Bartsch, C. F. Batchelder, B. A. Bean. J. E. Benedict, F. H. Benjamin, H. I. Berker, Maurice K. Brady, C. S. Brimley, Laura Brodie, E. J. Brown, C. P. Bull, Mr. Burns, Charles E. and May Danheim Burt, Ben Chesser, O. N. Cripps, S. R. Detwiler, C. T. Earle, Mr. Filer, W. K. Fisher, B. F. Fox, (Fla.), W. H. Fox (Tenn.), I. K. Godbey, L. L. Godbold, Geo. M. Gray (Fla.), I. E. Gray (N. C.), M. M. Green, Mr. Gutsell, E. B. Hardeman, Francis Harper, Theo. Holm, A. L. Holmes, A. H. Howell, J. W. P. Jenks, Remington Kellogg, J A. Loring, C. A. Ludwig, J. C. McNair, Mr. McNeal, E. B. Marshall, G. S. Miller, R. A. Mills, J. B. Mitchell, S. L. Morgan, C. A. Mosier, Wm. Palmer, Mr. Patton, R. P. Payne, J. L. Peters, A. M. Reese, A. G. Reynolds, W. R. Robbins, Mr. Savage, R. W. Shufeldt, E. Smith, Fanny Streeter, E. C. Tatman, W. J. Taylor, R. J. Thompson, H. N. Vare, B. L. C. Wailes, S. T. Walker, Wm. Wittfield, N. R. Wood, and R. M. Woodberry.

PAGE

10. Sides and back of head showing sharp horns and spines; tail shorter than body; body much flattened. Texas "horned toad." Introduced into Florida .... *Phrynosoma cornutum,* 356
10. Not with this combination of characters.. 11
11. Back scales without spiny posteriorly projecting points; femoral pores absent. Skinks 15
11. Back covered with spiny scales, which are strongly keeled; femoral pores present. Spiny lizards, or fence lizards.. 12
12. Distance between base of fifth toe of hind foot and tip of fourth toe decidedly greater than distance between tip of snout and tympanum.................. 13
12. Distance between base of fifth toe of hind foot and tip of fourth toe not decidedly greater than distance between tip of snout and tympanum. Eastern Spiny Lizard, Pine Lizard, or Common Fence Lizard..........*Sceloporus undulatus undulatus,* 354
13. Ground color of back often brown, olivaceous, or blackish, with light blue normally not predominant in the dorsal coloration; undulating dark dorsal cross-bars usually distinct, often heavy. Eastern Spiny Lizard, Pine Lizard, or Common Fence Lizard ....*Sceloporus undulatus undulatus,* 354
13. Ground color of body blue gray or olive gray, rarely light brown; undulating dark dorsal cross-bars usually reduced, not heavy, sometimes absent.............. 14
14. More than 33 scales from the occiput to the base of the tail, opposite hinder margin of thigh. Florida Fence Lizard...................*Sceloporus undulatus woodi,* 356
14. With 33 or fewer scales from the occiput to the base of the tail. Pensacolan Spiny Lizard (coastal plain of northwestern Florida)....*Sceloporus undulatus floridanus,* 353
15. Lower eyelid completely covered with small scales.. 16
15. Lower eyelid with a clear, transparent central part; body small, cylindrical; color bronz above, darker on the sides. Brown-backed Skink....*Leiolopisma unicolor,* 358
16. Back blackish, with exactly 5 prominent light lines of about equal intensity and width; the vertebral stripe forking on the head; young to adult in primary stage of development. Five-lined Skink, or "Scorpion"...........*Eumeces fasciatus,* 359
16. Back otherwise; if 5 stripes are present, the vertebral one weaker than the others and not distinctly forked anteriorly.. 17
17. More than 23 scales around the middle of the body........................ 19
17. With 23 or fewer scales around the middle of the body........................ 18
18. Light stripes more distinct, usually extended on tail; upper pair of light stripes closer together, usually separated by two whole and two half scale rows. Atlantic coastal plain in southern Georgia and northern Florida; also, the southern keys, Florida. Atlantic fragile Skink......................*Eumeces egregius egregius,* 359
18. Light stripes less distinct, faded posteriorly; upper pair of light stripes when visible, usually separated beginning several rows back of head by 4 whole and two half rows of scales. Florida, exclusive of the southern keys and the northeastern part. Gulf fragile Skink..............................*Eumeces egregius onocrepis,* 359
19. Two postmental plates present. Five-lined Skink, or Scorpion....*Eumeces fasciatus,* 359
19. One postmental plate present.. 20
20. A postnasal scale. Five-lined Skink, or "Scorpion"............*Eumeces fasciatus,* 359
20. No postnasal scale. Black Skink..........................*Eumeces anthracinus,* 358

LIST OF SPECIES

Hemidactylus turcicus (Linnaeus)

In 1915 (and again in 1921) this introduced European gecko was secured on Key West, Monroe county, Florida, by Geo. M. Gray, thus adding the species to the faunal list of the United States. The back of American specimens displays many conspicuous rounded tubercules. Other characters are: ventral scales smooth; body soft; pupil vertical like that in the pit viper eye; body soft, tan-colored, with a number of conspicuous flake-like dark-brown spots on the upper parts, but immaculate below.

Sphaerodactylus cinereus Wagler

A gecko from Key West, Monroe county, Florida (Gray, 1921), was identified as this species by Stejneger (1922), who reported it as new to the United States and as having been introduced from Cuba. On April 18, 1928, a second specimen was secured by J. S. C. Boswell on Key Largo, Monroe county, which is much nearer to the peninsular mainland, so the population appears to be migrating along the Florida keys.

The scales on the back of cinereus are finely granular while those of notatus of the same area are relatively large. The body of cinereus is brown, with numerous, small, light specks on the back and sides; but it is more or less immaculate below. There is no tendency toward longitudinal streaking in the color pattern.

Sphaerodactylus notatus Baird

This gecko was described from southern Florida in 1858, to which it may have been introduced from the Bahama Islands or Cuba (Stejneger and Barbour, 1933). It is much more abundant and wide-spread in this area today than the two recently introduced species just discussed.

The body of notatus is light to dark brown, with a tendency toward the display of longitudinal streaks anteriorly, especially on the top of the head and neck where a median dark band usually extends from the snout to between the shoulder or even farther. This dark streak is characteristically bordered on each side by a light stripe and then by a second dark band which extends through the eye. The under parts are either immaculate, or with faint, dark-brown flecks, which are most apt to appear on the throat.

ALABAMA, MOBILE: Mobile (Hurter Coll., June 9, 1900). Probably introduced, based on U. S. N. M. No. 59003.

FLORIDA, DADE: Lemon City (Brown, Aug. 8, 1903); Paradise Key (Barber, Feb. 1919); Royal Palm Hammock (Mosier, Apr. 1918). MONROE: Key Largo (Brady, Jan. 31, 1932); Key West (Brady, 1932); Tortugas (Bartsch, May 6, 1913).

Anolis carolinensis Voigt

The habits of the American "chameleon" have been rather fully discussed by various authors. The form is more abundant in the southern part of its range. A young specimen of the brood of 1933 was found in Lincoln county, Georgia, on July 19. It had a body length of 30 mm.

The color pattern is highly variable, both in the living and in the preserved state. Specimens in alcohol are light to dark, usually being blackish, gray, blue, greenish, or yellowish. The back is with or without dark markings, which are developed to varying degrees in different individuals. The under parts are extensively mottled to immaculate.

ALABAMA, BALDWIN: Orange Beach (Howell, Jan. 25, 1912). COOSA: Weogufka (Gutsell, June 19, 1911). CULLMAN: Ardell (Howell, May 30, 1914). MOBILE: Mobile (Howell, May 30, 1911). WILCOX: 2 mi. E. Pine Hill (Godbold, Oct. 18, 1919). Additional records from the literature: Autauga, Bibb, Dale, De Kalb, Greene, Jackson, Sumter, Talladega, and Tuscoloosa counties.

FLORIDA, BREVARD: Titusville (Green, Apr. 11, 1889); Micco (Jenks). COLLIER: Cape Romano (Mosier, Apr. 1887). COLUMBIA: Benton (Ball, June 2, 1929). DADE: Lee Hammock (Brady, Jan. 20, 1932); Lemon City (Brown,

1903); Paradise Key (Brady, 1932). DE SOTO: Orange Hammock (Palmer, Mar. 1895). LAKE: Eustis (Holm, Mar. 9, 1893). LEVY: Cedar Keys (Miller, Mar. 26, 1926). MONROE: Big Pine Key (Brady, 1932); Pinecrest (Brady, Feb. 21, 1932); New Found Harbor Keys (Bartsch, May 12, 1919); Ovot Bay, Cape Sable (Bartsch, May 9, 1919); Key West (Hardeman, Apr. 22, 1925). NASSAU: Amelia Id. (Vare, May 1, 1923). OCEOLA: Lake Kissimmee (Reese). PALM BEACH: Lake Worth Canal (Bean, Dec. 12, 1905); Ritta (Robbins, May 1918). POLK: Auburndale (Wood, 1912); Haines City (Shufeldt, June 1909); Lake Arbuckle (Palmer, Mar. 1895). ST. JOHNS: St. Augustine (Smith). SARASOTA: Miakka Lake (Barrett, June 19, 1918). SEMINOLE: Sanford (Tatman, Apr. 23, 1931). VOLUSIA: Daytona (Streeter, 1899). Literature: Alachua, Duval, Escambia, Marion, Pinellas, and Santa Rosa counties.

GEORGIA, CAMDEN: St. Marys (Batchelder, 1880). CHARLTON: Billy's Id. (Harper, Dec. 26, 1916); Cedar Landing (Chesser, July 22, 1931). LIBERTY: Riceboro (Thompson, Apr. 8, 1892). LINCOLN: Island above Price Id. in Savannah R. 3 mi. W. Parksville, S. C. (Burt, July 19, 1933). Literature: Berrien, Chatham, Randolph, and Ware counties.

MISSISSIPPI, ADAMS: Washington (Bailey, May 21, 1892). FRANKLIN: 3 mi. W. Meadville (Burt, June 15, 1934). JEFFERSON: (Hurter Coll., June 5, 1889). JONES: 2 mi. NW. Welch (Burt, June 14, 1934). LAFAYETTE: Oxford (Wailes). NEWTON: 4 mi. NE. Newton (Burt, June 14, 1934). NOXUBEE: 3 mi. E. Mashulaville (Burt, June 30, 1934). Literature: Hancock, Harrison, Kemper and Lowndes counties.

NORTH CAROLINA, COLUMBUS: Lake Waccamaw (Gray, July 3, 1933). Literature: Bladen, Brunswick, Carteret, Craven, Duplin, Harnett, Lenoir, Moore, New Hanover, Pender, Polk, Robeson, Stanly, and Wake counties.

SOUTH CAROLINA, DORCHESTER: Summerville (McNair). Literature: Aiken, Anderson, Berkeley, Charleston, and Hampton counties.

TENNESSEE: Literature: Blount, Hamilton, and Sevier counties.

Anolis stejnegeri Barbour

Barbour (1931) described this interesting form from Key West, Monroe county, Florida, making a paratype of U. S. N. M. No. 6002, a female from "Cape Puta." In March, 1932, M. K. Brady secured a fine series of topotypes (Nos. 85175-87), so the population of this "chameleon" is apparently thriving on Key West.

Sceloporus undulatus floridanus Baird

A comparison of the type specimen of this form (U. S. N. M. No. 2874, Pensacola, Escambia county, Fla., collector, Doctor Jefferies) with numerous spiny lizards from Texas and the southeastern United States, indicates that the name floridanus is based on a specimen of the undulatus group with approximately the lowest number of dorsal scales between the occiput and the base of the tail (opposite the posterior margin of the hind leg) to be found in this wide-ranging complex. However, an attempt to separate individuals of the undulatus species from the southeast into geographical races on the basis of the size of the dorsal scales leads only to failure. Counts ranging from 32 to 36 are numerous in material from northern Florida, Georgia, Alabama, Mississippi and even South Carolina, although the average figure is higher in

all of these places. As one goes northward (or southward into peninsular Florida) a weak tendency to increase the minimum figure is noted.

The previous conception of floridanus as a wide-ranging subspecies of the Mexican spinosus is untenable. If the Texan lizard now generally classified as *S. spinosus floridanus* is subspecifically distinct from a part or all of the Mexican population of spinosus proper, it must bear a new name. Otherwise the general population is to be known as *Sceloporus spinosus* Wiegmann, both in Mexico and in Texas.

The faded type specimen of floridanus is blue-gray in color, with dark markings scarcely evident. The sides are darker than the back; the under surface is white, with a few dark spots; a conspicuous black blotch lies in front of each shoulder; and there are 31 scales from the occiput to the base of the tail.

Two additional specimens of floridanus from Tallahassee, Leon county, Florida (Winchell, No. 4222), have bright blue belly patches and brilliantly colored throats, unlike the type; and while the type has only a black patch in front of each shoulder, these examples have the black suffusion extending ventrally across the throat to unite in the median line.

The type of floridanus has the typical dorsal coloration of woodi, rather than that of true undulatus. It has a lower average number of dorsal scales than woodi, counts as low as 33 rarely occurring in the latter form. As a subspecies, floridanus must be regarded as provisional. It is apparently poorly differentiated, but shows an average tendency away from both woodi and undulatus. More Sceloporus material is needed from the Florida Gulf Coast to settle the systematic problem involved. Possibly *Sceloporus spinosus floridanus* Allen (1932), from 3 mi. W. Biloxi, Harrison county, Mississippi, is based on a specimen of undulatus (as here defined) with relatively large dorsal scales.

Sceloporus undulatus undulatus (Latreille)

This is probably the commonest lizard of the southeast. Individuals were found in a wide range of habitats: about rocks, logs, tree trunks, brush piles, fence posts, old dumps and sawdust piles; under bark, boards, and flat pieces of tin and cardboard; at the margins of bodies of water, such as streams, springs and ponds; in hollow logs, and in leaves, grass and tin cans; in dense woods with underbrush, and in swamps and pine barrens; in barnyards, fields, and gardens; in lowlands and on mountains; and often on the road. When pursued, spiny lizards frequently climb trees or run along logs or rail fences.

Not all of the spiny lizards from Auburndale, Fla., the type locality of woodi, are characteristic of that form, which has hitherto been given full specific rank. In fact a large series of such lizards in the national collection (Nos. 62755-74) may be listed as intergrades between undulatus and woodi. The undulating dorsal bars are strong and the body brown in some individuals (undulatus type) while they are practically absent and the body is blue-gray in others (woodi type).

In 1933, a female of undulatus secured near Waterloo, S. C., on July 14 had nine eggs in the coelom. Later, on July 19, a young specimen, which measured 26.5 mm. in body length, was collected in Lincoln county, Georgia.

ALABAMA, AUTAUGA: Autaugaville (Howell, Apr. 16, 1912). BALDWIN: Bon Secour (Howell, Oct. 20, 1908). BIBB: Woodstock (Burt, Aug. 6, 1933). CLARKE:

1 mi. S. Fulton, and Thomasville (Burt, Aug. 6, 1933). COLBERT: Leighton (Howell, Apr. 23, 1914). CONECUH: Castleberry (Howell, Oct. 12, 1908). CULLMAN: Ardell (Peters, June 18, 1914). DE KALB: 7 mi. NW. Chavies and 7 mi. N. Ft. Payne (Burt, July 8, 1933). JACKSON: 5 mi. NE. Woodville (Burt, July 8, 1933). WALKER: 2 mi. E. Eldridge (Burt, July 10, 1933). WILCOX: Bethel, E. Pine Hill (Godbold, Oct. 14, 1919). WINSTON: Melville (Peters, May 1, 1914.) Literature: Barbour, Greene, Mobile, Montgomery, and Tuscaloosa counties.

FLORIDA, GADSEN: Chattahoochee (Bailey, Apr. 19, 1892). LAKE: Eustis (Holm, Feb. 28, 1893); Tavares (Brown, Feb. 14, 1928). LEVY: (Hurter Coll., 1891). NASSAU: (Hurter Coll., 1899). POLK: Auburndale (Wood, intergrades with woodi). Literature: Alachua, Leon, Pinellas, and Santa Rosa counties.

GEORGIA, GREENE: 2 mi. W. Greensboro (Burt, July 13, 1933). GWINNETT: Duluth, and 2 mi. W. Laurenceville (Burt, July 6, 1933). HOUSTON: 5 mi. N. Perry on Mossy creek (Burt, July 20, 1933). LINCOLN: 1 mi. E. Lincolnton (Burt, July 6, 1933), Island above Price Island 3 mi. W. Parksville, S. C. (Burt, July 19, 1933). MADISON: 3 mi. SW. Danielsville (Burt, July 3, 1933). RABUN: 2 mi. W. Burton Dam near shore of S. finger of Burton Lake, and 5 mi. E. Tiger (Burt, July 3, 1933). TOWNS: 1 mi. NE. Young Harris (Burt, July 1, 1933). WARE: 3 mi. E. Waycross (Burt, July 22, 1933). Literature: Baldwin, Berrien, Camden, Charlton, Cobb, Dade, Liberty, Muscogee, Randolph, Richmond, and Walker counties.

MISSISSIPPI, ADAMS: Washington (Bailey, May 24, 1892). AMITE: 4 mi. NE. Glading (Burt, July 1, 1934). CALHOUN: Derma (Burt, July 13, 1934). COVINGTON: 3 mi. E. Collins (Burt, June 14, 1934). FRANKLIN: 3 mi. W. Meadville (Burt, June 15, 1934). GREENE: Piave (Burt, June 30, 1934). HANCOCK: Bay St. Louis (Bailey, Apr. 22, 1892). JEFFERSON (Hurter Coll., July 15, 1889). JEFFERSON DAVIS: Bowie Creek Flats 7 mi. E. Prentiss (Burt, June 14, 1934). JONES: 2 mi. NW. Welch (Burt, June 14, 1934). LAWRENCE: 3 mi. W. Monticello (Burt, June 15, 1934). LINCOLN: 4 mi. SW. Brookhaven (Burt, June 15, 1934). NESHOBA: 2 mi. NW. Neshoba (Burt, June 14, 1934). NOXUBEE: 3 mi. E. Mashulaville (Burt, June 30, 1934). RANKIN: 2 mi. E. Pelahatchee (Burt, June 28, 1934). SCOTT: 8 mi. E. Forest, and 8 mi. NW. Lake (Burt, June 28, 1934). WAYNE: 5 mi. S. Clara Chicora (Burt, June 30, 1934). WEBSTER: 3 mi. SW. Tomnolen (Burt, June 30, 1934). WILKINSON: De Soto National Forest 34 mi. SE. Natchez (Burt, Aug. 2, 1936). Literature: Harrison, Kemper, Lowndes, and Lafayette counties.

NORTH CAROLINA, BUNCOMBE: Bent Creek Station 9 mi. SW. Asheville (Gray, June 3, 1933). DURHAM: Duke Univ. Campus (Gray, June 6, 1933). GATES: 7 mi. SW. Roduco (Burt, July 24, 1933). MACON: 2 mi. SE. Kyle, and 5 mi. SW. Aquone (Burt, June 7, 1932); 9 mi. W. Franklin on Wyah Bald road (Burt, July 10, 1932). Literature: Ashe, Cherokee, Edgecombe, Forsyth, Haywood, Henderson, Lenoir, New Hanover, Northampton, Orange, Robeson, Swain, Transylvania, and Wake counties.

SOUTH CAROLINA, CHEROKEE: 2 mi. NE. Cowpens (Burt, July 14, 1933). GREENVILLE: 1 mi. N. Merrittsville (Burt, July 3, 1931). GREENWOOD: 8 mi. NE. Greenwood on Saluda river bank (Burt, July 14, 1933). LAURENS: 5 mi. S. Waterloo (Burt, July 14, 1933). MCCORMICK: 1 mi. N. Modoc (Burt, July

13, 1933); 3 mi. W. Parksville (Burt, July 19, 1933). SALUDA: edge of Murray Lake 10 mi. E. Saluda (Burt, July 5, 1933). Literature: Abbeville, Aiken, Berkeley, Charleston, Darlington, Dorchester, Hampton, and Richland counties.

TENNESSEE, BENTON: Big Sandy (U.S.N.M.). BLOUNT: 4 mi. NE. Townsend (Burt, July 7, 1932). CLAIBORNE: Powell River Valley 5 mi. SE. Tazewell (Payne, Aug. 1, 1932). DAVIDSON: Nashville (Palmer, May 1897). DYER: Maxey (Morgan, 1900). HAMILTON: Lookout Mt. (Fox, Mar. 1882). HUMPHREYS: Duck R. 6 mi. SW. Waverly (Howell, July 14, 1910). MAURY: Columbia (Ludwig, Oct. 10, 1919). Literature: Fentress, Henry, Knox, Madison, Obion, Roane, Sevier, Shelby, Sumner, and Union counties.

Sceloporus undulatus woodi Stejneger

The ground color of the back of this somewhat incompletely differentiated subspecies of undulatus is usually blue-gray or olive-gray. Other characters are: dark, undulating dorsal crossbars usually much reduced, not heavy; stripes on sides distinct, indistinct, or absent; blue throat patches of adults usually separated medially; distance between base of fifth toe of hind foot and tip of fourth toe usually decidedly greater than the distance between the tip of the snout and the ear opening; usually over 35 scales from occiput to base of tail.

Some striped specimens of woodi are highly suggestive of certain examples of the middlewestern subspecies, consobrinus. The fourth toe of woodi is long, but so is the fourth toe of various specimens of typical undulatus. Both woodi and floridanus represent populations that show a series of average differences from a parent stock, no one of which is to be absolutely relied upon in making diagnoses; yet all of these divergences indicate definite phylogenetic trends, which will undoubtedly be analyzed with greater acumen when more specimens become available.

FLORIDA, BREVARD: Georgiana (Wittfield). BROWARD: I mi. N. Hallandale (Barbour, Apr. 1919). PALM BEACH: Lake Worth (Green, May 21, 1889). POLK: Auburndale (Wood, 1912, type); Haines City (Shufeldt). PUTNAM: Fruitland Park (Reynolds). Literature: Dade, Highlands, Lee, and St. Lucie counties.

Phrynosoma cornutum (Harlan)

Late in 1934 De Sola (p. 190) reported the occurrence of wild "horned toads" of this species from sandy areas near Miami, Dade county, Florida. Shortly afterward Goff (1935, p. 45) gave a second reliable indication of the finding of wild specimens in Florida, from near Leesburg, Lake county. This indicates that *Phrynosoma cornutum* has been successfully introduced into the state.

Cnemidophorus sexlineatus sexlineatus (Linnaeus)

This ground-inhabiting lizard is often abundant in grassy open spaces near woods, such as those along roadbeds, especially if the soil is sandy or of gravel. However, examples are occasionally found in the moist woods, even "under rotting logs" or "in rotting logs in the shade of large trees and close to muddy pools." In Horry county, South Carolina, an individual was in woods along the shore of the Atlantic ocean.

A newly hatched young example was secured near Midland, N. C., on

July 18, 1933. It showed the following measurements: body, 30 mm.; tail, 60; total length, 90. A somewhat older specimen taken near Leesville, S. C., on Aug. 14, 1932, had a body length of 34 mm.

ALABAMA, ABBEVILLE: Abbeville (Howell, June 10, 1911). CLARKE: 1 mi. S. Fulton (Burt, Aug. 6, 1933). DE KALB: 3 mi. SE. Valley Head (Burt, July 8, 1933). Literature: Autauga, Baldwin, Cullman, Greene, Jackson, Lee, Lowndes, Mobile, Montgomery, and Tuscaloosa counties.

FLORIDA, BROWARD: Ft. Lauderdale (Howell, June 25, 1918). DADE: Lemon City (Brown). JACKSON: 3 mi. N. Campbellton (Burt, July 2, 1931). LAKE: Eustis (Brown, Dec. 13, 1922). NASSAU: Amelia Id. (Vare, May 1, 1923). SARASOTA: Miakka Lake (Barrett, June 18, 1918). Literature: Alachua, Brevard, Duval, Escambia, Franklin, Jefferson, Lee, Manatee, Marion, Monroe, Orange, Palm Beach, Pasco, Pinellas, Polk, Santa Rosa, St. Lucie, Volusia, and Wakulla counties.

GEORGIA, CHATTOOGA: 5 mi. W. Summerville (Burt, July 8, 1933). GWINNETT: 4 mi. SW. Buford (Burt, June 30, 1933); 2 mi. W. Laurenceville (Burt, July 6, 1933), and Norcross (Burt, July 20, 1933). HOUSTON: Mossy Creek Valley 5 mi. N. Perry (Burt, July 21, 1933). LUMPKIN: 5 mi. SE. Neels Gap (Burt, July 1, 1933). RABUN: 2 mi. W. Burton Dam on shore of southern finger of Burton Lake (Burt, July 3, 1933). WALKER: 5 mi. S. Lafayette (Burt, July 8, 1933). Literature: Appling, Baldwin, Berrien, Camden, Charlton, Chatham, Grady, Toombs, Turner, and Ware counties.

MISSISSIPPI, BENTON: 2 mi. S. Spring Hill (Burt, June 12, 1934). CALHOUN: 3 mi. E. Calhoun City (Burt, June 13, 1934). COVINGTON: 3 mi. E. Collins (Burt, June 14, 1934). FRANKLIN: 2 mi. SW. McCall Creek (Burt, June 15, 1934). GRENADA: 7 mi. E. Grenada (Burt, June 13, 1934). JASPER: 7 mi. S. Bay Spring (Burt, June 14, 1934). JONES: 8 mi. W. Laurel (Burt, June 14, 1934). LAWRENCE: 3 mi. W. Monticello (Burt, June 15, 1934). LINCOLN: 4 mi. SW. Brookhaven (Burt, June 15, 1934). MARION: 3 mi. SW. Foxworth (Burt, June, 1934). NEWTON: 1 mi. N. Doolittle (Burt, June 14, 1934). WALTHALL: 2 mi. NW. Tylertown (Burt, July 1, 1934). WILKINSON: Ireland (Burt, July 2, 1934). Literature: Adams, Hancock, Harrison, Lafayette, and Marshall counties.

NORTH CAROLINA, BRUNSWICK: 2 mi. SW. Shallotte (Burt, July 24, 1933). CABARRUS: 1 mi. S. Midland (Burt, July 18, 1933). DURHAM: 1 mi. S. Hope Valley (Burt, July 15, 1933). WARREN: 3 mi. N. Wise (Burt, June 26, 1933). Literature: Buncombe, Camden, Carteret, Catawba, Cherokee, Dare, Lenoir, Moore, New Hanover, Orange, Pamlico, and Wake counties.

SOUTH CAROLINA, GREENWOOD: Saluda R. Valley 8 mi. NE. Greenwood (Burt, July 14, 1933). HORRY: Little River (Burt, July 24, 1933). LAURENS: 5 mi. S. Waterloo (Burt, July 14, 1933). LEXINGTON: 5 mi. SE. Leesville (Brodie, Aug. 14, 1932). SALUDA: Murray Lake 10 mi. E. Saluda (Burt, July 18, 1933). Literature: Aiken, Anderson, Beaufort, Berkeley, Charleston, Darlington, Dorchester, Hampton, and Richland counties.

TENNESSEE, BENTON: Big Sandy (Thompson, June 21, 1892). FAYETTE: 3 mi. W. Oakland, and 6 mi. SE. Somerville (Burt, June 12, 1934). HAMILTON: 6 mi. SE. Ooltewah (Burt, June 5, 1932). SEQUATCHIE: 2 mi. NE. Dunlap (Burt, July 26, 1932). Literature: Davidson, Decatur, and Henry counties.

Leiolopisma unicolor (Harlan)

This elongate little ground skink is very secretive, and when disturbed it may scamper into almost any available crevice or other natural shelter. The species is often abundant, especially about moist woods.

ALABAMA, BALDWIN: Perdido Bay (Gutsell, Sept. 9, 1911). MOBILE: (Fisher, May 1886). WILCOX: Arlington (Burt, Aug. 6, 1933). Literature: Autauga, Baldwin, Etowah, and Montgomery counties.

FLORIDA, BREVARD: Georgiana (Wittfield). DADE: Lemon City (Brown); Miami (Brady, Apr. 12, 1932). DE SOTO: Avon Park (U. S. N. M.). LAKE: Tavares (May 1930). LEVY: Cedar Keys (Miller, Mar. 17, 1926). MONROE: Key West (Brady, Mar. 1932). OSCEOLA: Kissimmee (Bailey, Feb., 1911). POLK: Auburndale (Palmer, Feb. 13, 1917). SANTA ROSA: Milton (Walker). Literature: Alachua, Duval, Escambia, Marion, Orange, Pinellas, Seminole, and Volusia counties.

GEORGIA, GWINNETT: Thompson's mill (Allard, May 1910). LIBERTY: Riceboro (Loring, Apr. 6, 1892). MCINTOSH: 2 mi. N. Darien (Burt, July 22, 1933). RABUN: 5 mi. SE. Clayton, and 7 mi. N. Pine Mountain (Burt, July 2, 1933). Literature; Berrien, Charlton, Randolph, and Richmond counties.

MISSISSIPPI, AMITE: 2 mi. W. Liberty (Burt, July 1, 1934). COVINGTON: 3 mi. E. Collins (Burt, June 14, 1934). HANCOCK: Bay St. Louis (Bailey, Apr. 22, 1892). JEFFERSON: (Hurter Coll., July 15, 1889). JEFFERSON DAVIS: Bowie Creek flats 7 mi. E. Prentiss (Burt, June 14, 1934). LAWRENCE: 7 mi. W. Monticello (Burt, June 15, 1934). LINCOLN: 4 mi. SW. Brookhaven (Burt, June 15, 1934). NEWTON: 1 mi. N. Doolittle (Burt, June 14, 1934). WALTHALL: 2 mi. NW. Tylertown (Burt, July 1, 1934). WILKINSON: Ireland (Burt, July 1, 1934). Literature: Adams, Harrison, and Jackson counties.

NORTH CAROLINA, DURHAM: Duke University Campus (Gray, 1933). Literature: Craven, Duplin, Forsyth, Lenoir, New Hanover, Orange, and Wake counties.

SOUTH CAROLINA, OCONEE: 4 mi. SW. Westminister (Burt, June 29, 1933). Literature: Aiken, Anderson, Charleston, and Richland counties.

TENNESSEE. Literature: Dyer, Hamilton, Henry, Obion, and Shelby counties.

Eumeces anthracinus Baird

This is an extremely rare skink in the Southeast. Cope (1880) described a specimen from Mobile, Mobile county, Alabama, as *E. pluvialis,* which he had previously reported as *anthracinus* (1877). The type is not available, but a recently collected topotype of *pluvialis* has been sent to the U. S. National Museum by H. P. Loding. It shows the essential features of anthracinus. The body has four light stripes, which border the two dark lateral bands. Other characters are: ventral color bluish slate; digits slender; 24 scales around middle of body; 48 scales from occiput to base of tail; no postnasal; one postmental.

A specimen from Transylvania county, North Carolina, agrees well with the above, except in regard to the following details: body with greenish tinge, especially below; 26 scales around the middle of the body; 51 scales from the occiput to the base of the tail.

ALABAMA, MOBILE: Mobile (Loding, U. S. N. M. neotype of *pluvialis*, see Taylor, 1935, pp. 385-386 for comments).

MISSISSIPPI. Literature: Green county.

NORTH CAROLINA, TRANSYLVANIA: Looking Glass creek (Benedict, 1907). Literature: Buncombe county.

Eumeces egregius egregius (Baird)

The color of the body is darker anteriorly than on the tail of most specimens of this small species. The general ground color is usually gray or brown. A dark longitudinal line on each side is bordered above by a light line, which is usually distinct from the snout and above the eye to the base of the tail on each side. The under parts of both *egregius* and *onocrepis* are uniform yellowish. Some other common characters are: supraoculars 3; postmentals 2; no postnasal; 18 to 22 (usually 20) scales around middle of body.

FLORIDA, MONROE: Big Pine Key (Barber, Mar. 6, 1919); Key West (Brady, Mar. 24, 1932). Literature: Alachua and Duval counties.

GEORGIA. Literature: Charlton county.

Eumeces egregius onocrepis (Cope)

Taylor (1935) is followed in differentiating this subspecies from the preceding. The data indicate a definite morphological divergence, although the distribution of the two populations is peculiar in that onocrepis is central in position (occupying the bulk of peninsular Florida) while egregius occurs both to the north and to the south.

This variant is characterized by the fading of the light stripes from the rear toward the front. If a lower lateral stripe is present, it will be less distinct than the upper lateral stripe and usually it does not extend as far posteriorly.

FLORIDA, BROWARD: Oakland Park (Brady, Dec. 1931). DADE: Lemon City (Brown, 1902). LAKE: Lake Joanna (Brown, Apr., 1923). POLK: Auburndale (Wood, Feb., 1918). Literature: Brevard, Hernando, Pinellas, Volusia, and Palm Beach counties.

Eumeces fasciatus (Linnaeus)

Lacerta fasciata Linnaeus, 1758, p. 209 (type locality, Carolina).
Eumeces fasciatus Cope, 1875, p. 45. Stejneger and Barbour, 1933, p. 81. Burt, 1935, p. 301. Taylor, 1935, p. 188.
Scincus laticeps Schneider, 1801, p. 189 (no type locality).
Eumeces laticeps Peters, 1864, p. 49. Taylor, 1932 a, pp. 268-271; 1932 b, pp. 251-261; 1935, p. 212.
Eumeces inexpectatus Taylor, pp. 251-261 (type locality, Citrus county, Florida); 1935, p. 224.

This is a very widespread, plastic, variable, southeastern skink, which shows a remarkable series of ontogenetically produced color pattern phases during development. It occurs in a wide variety of situations, but usually not far from trees or wood products, preferably where there is a moderate supply of moisture. Many individuals were found in rotted wood, as in fallen logs, and many others were located under loose bark. One could nearly always be collected under boards on sawdust piles at old logging sites. Pursued individuals seek shelter in almost any available crevice, frequently climbing trees (often to considerable heights,) and they may enter knotholes, burrows among

roots, or hollow logs. Some were secured under flat pieces of tin at old dump heaps or under cardboard. The newly hatched young seem to require a moister habitat than older examples, frequently appearing on moss near springs or at the edge of streams, as well as in or on rotted wood.

Several matters pertaining to the taxonomy of this species will be presented at this point.

Prior to 1932, either in connection with previous problems begun in 1926, or as a preliminary step in the phylogenetic study of the genus Eumeces (planned as a joint project with Dr. Edward H. Taylor of Kansas University as early as 1929), I had examined the bulk of the lizards of the *Eumeces fasciatus*—complex in the museums of the United States. On February 1, 1932, Taylor forwarded an independently prepared manuscript on "*Eumeces laticeps:* a Neglected Species of Skink" to me for criticism. I found that I could not, on the basis of my studies of Eumeces, conscientiously concur in the recognition of the new form. In fact, I desired a delay in publication with the idea that a joint understanding would tend to present a clearer view of the matter. In a letter dated February 5, 1932, Taylor informed me that my reply had been anticipated and that he was willing to "assume all risks," writing "I will present it under my name alone and take the consequences." After some discussion of the matter with others and careful consideration I forwarded my research data on Eumeces and withdrew from the project. On May 15, 1932, the paper was published in the Bulletin of the University of Kansas (33:251-258, pls. 17-18).

While admitting that the two forms, fasciatus and laticeps, go through the same general type of development and have practically the same color pattern, Taylor selected maximum size and about 16 other minor contrasts, as serving, on the whole, for diagnosis. Judging from the key, presented in his large monograph (1935, p. 187), the outstanding feature specified for laticeps appears to be its larger maximum size. Both forms occupy the same area, with the exception that the "giant" laticeps does not occur in the northernmost part of the range where there is a shorter growing season each year both for cold-blooded animals and for plants.

Before discussing the other points involved, it may be stated that there is a distinct need in herpetology not only for the experimental evaluation of the effect of environmental factors upon quantitative characters like size, but also for the more detailed consideration of postnatal ontogeny and sexual dimorphism. In connection with previous data-taking (*Cnemidophorus, Ameiva, Crotaphytus, Callisaurus* and *Holbrookia*), it has been apparent that bodily proportions change with age, with some parts becoming more prominent as others decline. There is a tendency for the relative overemphasis of these alterations in the adult male.

It seems obvious that if in any large population (including man) one should select the individuals showing the upper extreme in size, as a probable new species, he would find average (but graded and more or less indefinable) contrasts upon which to support his argumentation. Size is conceded to be influenced both by hereditary and nonhereditary factors and even the young of those near either variational extreme will tend to show certain peculiarities that are in average contrast to features in evidence at the mean of variation. As Shull and others have indicated in current texts, even if we disregard en-

vironmental factors entirely, it is found that quantitative characters show remarkable gradation over a greater or lesser field known as the range of variation. This is because they are due not to the hereditary action of one set of genes, but to the interaction of many sets of these allelomorphs. Qualitative characters are easier to measure because they are usually less influenced by the environment and because the hereditary mechanism is such that they do not so frequently show blending inheritance.

It is not surprising that laticeps in the present case should show such quantitative features as larger, thicker claws, wider heads, longer limbs, shorter axilla to groin measurement, and certain changes in the proportionate arrangement of scales. Taylor draws attention to the fact that the "paucity of young specimens of laticeps in collections is a matter of no little interest" and I agree with him. He states that this is strongly suggestive of the fact that the eggs are laid in trees and that the young are arboreal from the beginning. I believe that it would be very hard to prove the diagnostic value of this point. I have found these skinks and their eggs and young about wood all of the way from the ground level to positions among the branches of standing trees.

Schmidt (1936, p. 242) in reviewing Taylor's monograph (1935) for Copeia stated that "The reasons for the distinction of *Eumeces laticeps* from *Eumeces fasciatus* . . . are now set forth in detail. This seems . . . still not completely proven. . . . The general coincidence in the range of the two forms is great; the failure of fasciatus to reach the laticeps size in the north conforms with the distribution of size within widespread species of reptiles; and the principal scale character cited, the arrangement of the temporal scales, might be suspected of some alteration with the widening of the head in adult males, while the difference in postlabials may be an alternative character. Against this must be set, in addition to Taylor's conclusion, based on many specimens, the findings of Noble and Mason (1933), who report a larger egg size and more rapid growth in laticeps, which can only be explained, if the species is *not* distinct, by the assumption that these differences are due to the larger size of the mother. Further work, however, should clarify the status of laticeps beyond question." While I believe that the weight of evidence is largely against laticeps, Schmidt's view fully coincides with my own.

The taxonomy of both *Eumeces fasciatus* and *E. laticeps* (if one were to give the second form recognition) seems further complicated by the description of *E. inexpectatus* from the same area (Taylor, 1932 b). A relatively narrow width of the median subcaudal scales was advanced as the chief diagnostic feature of the latter form. *E. inexpectatus* was held to be "somewhat intermediate between *Eumeces laticeps* and *E. fasciatus*" in other characters (Taylor, 1935, p. 225) and in view of the forelying discussion of laticeps these need scarcely be mentioned here. The character of the median subcaudals of Eumeces has been used in various keys as a criterion for the recognition of species, and it may be of value in certain cases. However, in examining specimens of fasciatus I note that there is both age and individual variation in these units. The tail of old specimens, especially adult males, tends to be "fat" at the base. The median subcaudals (which are usually wider than the lateral rows) appear to grow laterally at a somewhat more rapid rate than longitudinally. Taylor describes inexpectatus as a population, averaging in the maximum slightly larger than fasciatus, but much smaller than laticeps. The

manner of caudal growth might explain this situation. In places of ecological prosperity the older examples of inexpectatus would be expected to develop fat tails and if the subcaudals were gradually expanded laterally they would finally brand the bearer as being laticeps instead of the preëxisting form. Thus, I am not inclined to recognize inexpectatus as distinct on the basis of the data thus far advanced.

Some life history data on fasciatus may be recorded here. During the summer females were frequently found to be coiled about egg masses, which were almost invariably placed in moist, rotted wood, either in a log, in a standing tree trunk, or about a sawdust pile. When the young first appear they are protected by the female, who coils about them in the same manner as she does about the eggs. After a few days the young leave the nest and wander away, apparently beginning to shift for themselves.

On June 6, 1932, a young specimen of the brood of 1931 was found on moss at Lula Falls on Lookout Mountain. The eggs are laid at a later date. A female collected on June 3, 1933, near Asheville, N. C., has eight eggs in the coelom. The deposition of the eggs may take place later in June, however, for an adult and eight eggs (with well-developed embryos) was secured in Scott county, Mississippi, on June 28, 1934. On July 7, 1933, a nest with a female and six eggs was disclosed under a log on a sawdust pile near Emma, Ga., and a male was located under a board near by. An adult and six eggs was discovered under an old fence post near Elk River in Limestone county, Alabama, on July 8, 1933, and an adult with ten eggs was found the next day at an old logging camp near Fulton, Miss.

The deposition of eggs probably takes place over a considerable length of time and the period of incubation is, no doubt, variable. Eggs placed in moist, shaded situations in large logs may be kept at a lower temperature than those in drier, more exposed places and thus develop more slowly. A nest with whole eggs, pipped eggs, and released young, guarded by the female, was revealed in a rotted log near Glading, Miss., on July 1, 1934. The body of one of the young measured 23 mm., tail 35. Young taken in Lincoln county, Georgia, on July 19, 1933, measured 24.5 to 25 mm. in body length, tail 32 to 37. Later, on July 21, near Perry, Ga., young had body lengths varying from 28 to 30 mm., tail 31 to 36. On the next day, a young specimen from Glynn county, Georgia, measured 32 mm. in body length.

ALABAMA, BALDWIN: Perdido Bay (Gutsell, 1910). COLBERT: Leighton (Howell, Apr. 24, 1914). JACKSON: Sand Mountain (Howell, 1913). LIMESTONE: 14 mi. W. Athens near Elk River (Burt, July 8, 1933). MARION: 1 mi. SE. Texas (Burt, July 9, 1933). MONTGOMERY: Barachias (Howell, June 14, 1911). Literature: Autauga, Bibb, Butler, Calhoun, Choctaw, Green, Lee, Madison, Mobile, Perry, Sumter, and Tuscaloosa counties.

FLORIDA, DADE: Lee Hammock (Brady, Jan. 20, 1932); Lemon City (Brown, 1903); Royal Palm Hammock (Mosier, 1918). FRANKLIN: Apalachicola (Morgan). LAKE: (Brown, Mar. 1928). LEE: (Hurter Coll., June 19, 1910). MONROE: Key West (Filer, Jan. 5, 1923). NASSAU: Amelia Id. (Vare, May 1, 1923). OSCEOLA: Lake Kissimmee (Reese). PALM BEACH: Ritta (Robbins, May 1918); Lake Worth (Green, May 21, 1889). POLK: Auburndale (Wood, Apr. 1912). SEMINOLE: Chuluota (Mills). VOLUSIA: New Smyrna (Fox, 1899).

Literature: Alachua, Brevard, Citrus, Columbia, Duval, Hillsborough, Leon, Manatee, Marion, Orange, Pasco, Pinellas, Sarasota, and St. Lucie counties.

GEORGIA, BRANTLEY: 1 mi. W. Hoboken (Burt, July 22, 1933). COLUMBIA: 2 mi. NW. Evans (Burt, July 6, 1933). DAWSON: 8 mi. NW. Emma (Burt, July 7, 1933). GLYNN: 5 mi. W. Brunswick (Burt, July 22, 1933). GWINNETT: Thompson's Mill (Allard, 1908). HOUSTON: 5 mi. N. Perry (Burt, July 21, 1933). LIBERTY: Riceboro (Thompson, Apr. 8, 1892). LINCOLN: Island in Savannah R. above Price Island 3 mi. W. Parksville, S. C. (Burt, July 19, 1933); 1 mi. E. Lincolnton (Burt, July 6, 1933). LOWNDES: 2 mi. SE. Valdosta (Burt, July 21, 1933). STOKES: Moore's Knob (Benedict, May 1928). TOWNS: 1 mi. NW Osborn (Burt, July 1, 1933). Literature: Berrien, Camden, Charlton, Chatham, Cobb, Dade, Fulton, Grady, Heard, Muscogee, Randolph, Richmond, Thomas, Turner, and Walker counties.

MISSISSIPPI, AMITE: 4 mi. NE. Glading (Burt, July 1, 1934). JEFFERSON DAVIS: Bowie Creek Flats 7 mi. E. Prentiss (Burt, June 14, 1934). LINCOLN: 4 mi. SW. Brookhaven (Burt, June 15, 1934). MADISON: right bank of Pearl R. 9 mi. SE. Canton (Burt, June 28, 1934). MONTGOMERY: Sibleyton (Burt, June 13, 1934). NOXUBEE: 3 mi. E. Mashulaville (Burt, June 30, 1934). SCOTT: 8 mi. NW. Lake (Burt, June 28, 1934). TAWAMBA: 9 mi. NE. Fulton (Burt, July 9, 1933). WAYNE: 5 mi. S. Clara Chicora (Burt, June 30, 1934). WILKINSON: De Soto National Forest 24 mi. SE. Natchez (Burt, Aug. 21, 1936). Literature: Adams, Hancock, Harrison, Jackson, Lafayette, Lowndes, and Perry counties.

NORTH CAROLINA, BEAUFORT: 14 mi. N. Beaufort (Burt, July 24, 1933). BUNCOMBE: 9 mi. SW. Asheville (Gray, June 3, 1933). COLUMBUS: Lake Waccamaw (Marshall, 1931). DARE: Hatteras on Hatteras Id. (Kellogg, May 25, 1927). DURHAM: Duke Univ. Campus (Gray, 1933). NEW HANOVER: Cape Fear R. at Wilmington (Nov. 11, 1906). UNION: 11 mi. N. Monroe (Burt, July 18, 1933). Literature: Camden, Carteret, Catawba, Cherokee, Craven, Granville, Guilford, Jones, Lenoir, Macon, Orange, Robeson, Transylvania, Vance, and Wake counties.

SOUTH CAROLINA, LEXINGTON: 5 mi. SE. Leesville (Brodie, Aug. 14, 1932). Literature: Abbeville, Anderson, Beaufort, Berkeley, Charleston, Dillon, Edgefield, Hampton, Richland and York counties.

TENNESSEE, HAMILTON: Lula Falls on Lookout Mt. (Burt, June 6, 1932). HICKMAN: 13 Mi. NE. Centerville (Burt, July 27, 1932). KNOX: Knoxville (Mitchell). MONTGOMERY: Clarksville (Howell, 1910). ROANE: 2 mi. S. Kingston (Burt, July 27, 1932). Literature: Benton, Blount, Carroll, Cumberland, Dyer, Franklin, Henry, Houston, Madison, Obion, Rhea, Sevier, Shelby White, and Williamson counties.

Neoseps reynoldsi Stejneger

The body of this skink is silvery white to dark brown, and a conspicuous dark bar extends from the snout through the eye on each side. This bar tends to end back of the eye in light individuals, but it may be continued backward as a dilute lateral dark band in the darker individuals. In the type specimen this band extends past the insertion of the hind legs and then along the base of the tail, where it gradually diffuses away. The back is often covered with

small, dark-brown spots or patches. The legs are vestigial, without the normal number of digits.

FLORIDA, DADE: Miami (Brady, Feb., 1932). LAKE: Spring Lake near Fruitland Park (Reynolds, Mar. 1910). POLK: Auburndale (Palmer, Feb. 13, 1917); Winterhaven (Gray, Mar., 1916).

Rhineura floridana (Baird)

This elongate, legless, earless, eyeless, degenerate, wormlike lizard is found only in Florida. When preserved its body is yellow or white, but in life it is rose-colored.

FLORIDA, ALACHUA: Waldo (Godbey, Aug. 2, 1884). DE SOTO: Sebring (McNeal, Feb., 1914). LAKE: Fruitland Park (Brown, Oct. 25, 1922); Lake Joanna (Brown, Apr., 1923); Tavares (Brown, Feb. 9, 1928); Umatilla (Fisher, July, 1888). POLK: Auburndale (Wood, Feb., 1918). Literature: Columbia, Manatee, Orange, Pinellas, and Volusia counties.

Ophisaurus ventralis (Linnaeus)

The color pattern of this species is highly variable throughout the southeast and no significant geographical differentiation is evident in the present series. Young examples are apparently always striped, having several distinct longitudinal dark bands of varying widths and intensities in evidence on the back and sides. This pattern is retained with varying degrees of retrogression in the adults. At one extreme complete retention of the juvenile pattern is noted and at the other the ontogenetic development of transverse light markings, which may spread from spots, is so marked that practically all of the dorsal and lateral scales come to have some white flecks or emarginations as extensions from these areas. The longitudinal dark bands are broken as the white markings spread transversely. In intermediate examples both longitudinal striation and transverse light checkerings are in evidence. In some old specimens every scale has a dark center and a light emargination.

ALABAMA, LAUDERDALE: Smithsonia (Banks, Sept., 1924). MOBILE: Saraland (Hurter Coll., 1910). Literature: Autauga, Baldwin, St. Clair, Tuscaloosa, and Walker counties.

FLORIDA, COLUMBIA: Benton (Ball, June, 1929). DADE: Lemon City (Brown); Miami (Brady, 1932); Opis (Bull, June 1899). LAKE: Eustis (Brown, Dec. 10, 1922); Tavares (May 1930). MANATEE: Bradenton (Earle, 1927). PINELLAS: Dunedin (Holmes, Feb., 1915); Gulfport (Reynolds). VOLUSIA: New Smyrna (Detwiler). Literature: Alachua, Brevard, Charlotte, Duval, Escambia, Marion, Orange, and Palm Beach counties.

GEORGIA, BERRIEN: Alapaha (Taylor, 1883). LIBERTY: Riceboro (Bailey, April 6, 1892). Literature: Charlton and Pulaski counties.

MISSISSIPPI. Literature: Hancock, Harrison, and Lafayette counties.

NORTH CAROLINA, DARE: Hatteras on Hatteras Id. (Kellogg, May 25, 1927). Literature: Beaufort, Bladen, Brunswick, Carteret, Craven, Iredell, New Hanover, Orange, and Wake counties.

SOUTH CAROLINA, AIKEN: Aiken (Cripps, Oct., 1903). BERKELEY: Oakley (Berker, Sept. 5, 1879); Wando (Anderson). DORCHESTER: Jedburg (Brodie,

May 29, 1932). ORANGEBURG: Orangeburg (Burns, June 8, 1886). Literature: Barnwell, Charleston, Georgetown, Greenville, and Richland counties.

TENNESSEE, BRADLEY: Cleveland (Patton). Literature: Knox and Roane counties.

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Occurrence of Capillaria (Nematoda) in a Colony of Pigeons, and Methods of Control[1]

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Little is known of *Capillaria columbae* as a parasite of pigeons. Cram (1930) stated that enteritis, at times severe, may be caused by *C. columbae* in chickens and pigeons.

During the years 1931-'33, the author had the opportunity of making daily observations upon a colony of pigeons, including 150 mated pairs and about 200 unmated birds. In the summer of 1931 many young pigeons from fifty to seventy days of age died. The principal symptoms were absence of appetite, droopiness and diarrhea.

Post-mortem examination of several of these pigeons showed emaciation and acute enteritis of the entire postgastric intestine. Microscopic examination of sectioned material revealed invasion of the villi by *Capillaria columbae,* a single worm often having penetrated several villi. The columnar epithelium appeared to be the preferred tissue for invasion.

Other than the mechanical injury to the villi caused by the penetration of the worm and some congestion, no specific pathological condition was observed.

Vermifuges were tried as a means of controlling the parasites. Administration of carbon tetrachloride and hexylresorcinol failed to free the infested birds of capillaria even after overcoming the problem of regurgitation of the vermifuge. However, after adopting the practice of cleaning all pens containing young pigeons every ten days, or at weekly intervals in the summer, only a few pigeons showed symptoms of capillaria infestation during the summer of 1932, and no symptom of infestation was observed during the summer of 1933.

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Further Observations on Reproduction in Guinea Pigs Fed Vitamin C at Different Levels[1]

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INTRODUCTION

The guinea pig has been used frequently as a subject for experimental diets and most often growing postnatal animals have been selected. The purpose of this experiment has been to determine the effects of vitamin C deficiency upon female guinea pigs during pregnancy and lactation and upon the developing embryos and the young during lactation.

REVIEW OF LITERATURE

Definitions of a minimum protective dose have been set up and used in connection with the use of the guinea pig for biological assay to determine the vitamin C content of a food.

A minimum protective dose of vitamin C has been defined as that quantity of food, which when fed per 300 grams of body weight daily for ninety days, separate from the daily ration, will protect a standard guinea pig from scurvy (*12*).

Considerable difference of opinion exists as to the amount of various foods necessary for complete protection. In one instance it has been reported that 1.5 c. c. of orange juice per 300 grams body weight afforded full protection (*10*). Three c. c. of orange juice or tomato juice have been considered a more adequate amount for full protection (*10, 12*). Three and five tenths c. c. of the juice of "the Northern wild cloud berries" per 300 grams body weight gave full protection against scurvy in guinea pigs (*8*).

Vitamin C deficiency in the earlier stages of pregnancy of young animals resulted in premature birth or in dead fetuses, but older animals and those in the latter half of gestation give birth to living and apparently mature offspring according to Ingier (*9*). On the other hand, it has been found that guinea pigs given a vitamin C supplement of 5 c. c. or less of tomato juice or orange juice per 300 grams body weight failed to give birth to living young. This was true whether the mothers were pregnant before they were put on the experiment or became pregnant during the experiment. No pregnancies were obtained when the supplement was less than 3 c. c. of orange juice or tomato juice (*11*). The weight of the guinea pigs which received 3 c. c. of orange juice per 300 grams body weight was not fully normal according to the growth curve of Bessesen and Carlson (*2*).

It has been found that guinea pigs thrive better when they have a certain amount of roughage in addition to the simplified diet and the vitamin C supplement (*7*).

1. Contribution No. 152 from the Department of Home Economics and No. 179 from the Department of Zoölogy, Kansas State College.

MATERIAL AND METHODS

The guinea pigs for this experiment were obtained from Dr. H. L. Ibsen's colony. The Sherman, LaMer, Campbell vitamin C-free diet was fed to all guinea pigs as a basic ration. A high grade of filter paper was supplied as roughage. A liberal amount of the paper was accessible to all animals at all times. Greens were used as a supplement for the positive control animals, and orange juice at three levels was the source of vitamin C for the experimental groups. The negative control animals received no antiscorbutic supplement. Each animal was bred before she was put on the experiment.

Positive Controls.—Twenty-four females were used as positive controls. Every one of the positive controls was pregnant and gave birth to living young at term. Fifteen of these mothers were young animals which had never reproduced before. Eight had had one litter previously and one had had three other litters. During the experiment the growth curves were normal, and there was no instance of an open vagina nor hemorrhage. There were 69 young, which averaged 105 grams at birth.

Experimental Animals.—The experimental animals, like the positive controls, were bred before they were put on the experimental diet.

Table I summarizes the data related to those females which received orange juice as a supplement. Four females were given orange juice ad libitum; four were given 10 c.c. of orange juice per 300 grams body weight and eight were given 5 c.c. of orange juice per 300 grams body weight. One of the animals on 10 c.c. of orange juice died early in the experiment and is not included in the table. Q-13 aborted at 61 days. There were seven young, four of which were born alive.

Three of the females which had orange juice ad libitum produced living young. The young of Q-14, were nearly a week premature. Q-3 aborted at 56 days. There were three embryos, all of which were dead when found. These seven young averaged 81 grams each as compared with an average of 105 grams for the young born of pregnant females on greens as a supplement. Although the young of Q-14 were premature they weighed as much as those of O-2 and more than those of Q-2.

Of the three females which received 10 c.c. of orange juice per 300 grams body weight all were pregnant. All the young were born prematurely and in only one case were any living. Four of the seven young born to Q-13 were alive when born, but they were small and lived only a short time.

Five of the eight females on 5 c.c. of orange juice per 300 grams body weight became pregnant and three gave no evidence of pregnancy. Three of the five aborted at 44, 45 and 54 days, respectively. Bleeding at the vagina and the general behavior of the animal in each of the other two cases indicated that abortion was about to take place so they were killed and examined. E-6 had two embryos which were near to term and H-5 had three embryos which were sixty days.

Q-12 was pregnant when added to the guinea-pig colony. Her diet had been supplemented by sprouted oats. After parturition she was bred and placed on a supplement of 5 c.c. of orange juice per 300 grams body weight. She gained in weight for about a month and then began to lose weight. Progressive losses continued for a period of six weeks when she was killed. An

TABLE I.—Orange juice as supplement

Name.	Parturition.	Weight after parturition, gms.	Litter size.	Weight of litter, gms.	Remarks.
			A. Orange Juice ad Libitum		
O-2	First	708	3	232	———
Q-2	First	608	2	153	———
Q-3	First	649	....	....	Aborted at about 56 days; 3 young.
Q-14	First	554	2	183	62 days; young living.
			B. Orange Juice 10 cc per 300 Grams Body Weight		
Q-4	First	600	....	....	Aborted at 57 days; 3 young.
Q-0	First	632	....	....	Aborted at about 44 days; not certain of number; were partly eaten when found.
			C. Orange Juice 10 cc per 300 Grams Body Weight Plus Yeast		
Q-13	Second	534	....	....	Aborted at 61 days; 7 young; 4 born alive.
			D. Orange Juice 5 cc per 300 Grams Body Weight		
E-6	First	341	2	....	Bleeding at vagina; feared abortion; killed; two embryos at almost term.
F-6	Second	455	....	....	Aborted at 44 days; number of young uncertain.
J-10	Second	476	....	....	Did not become pregnant.
H-2	Second	420	....	....	Did not become pregnant.
H-5	Second	445	....	....	Began to lose weight; killed; 3 embryos; 60 days.
O-5	Third	645	....	....	Aborted at 54 days; 3 embryos.
K-3	Second	775	....	....	Aborted at 45 days; 4 young.
Q-12	Second	717	....	....	Continued to lose weight; killed after 72 days on experiment; was not pregnant; had lost 263 grams.

examination gave no indication of pregnancy. She weighed 263 grams less than when she was put on the experiment.

Some of the mothers were used more than once in the experiment. K-2, L-9, and Q-6 were used as positive controls a second time; Q-13 was used as a positive control while producing her first litter and then was put on 10 c. c. of orange juice per 300 grams body weight during her second pregnancy; Q-0 and Q-4 were on 10 c. c. of orange juice per 300 grams body weight during their first pregnancies and were transferred to positive controls during the second pregnancies; 0-5 was on 5 c. c. of orange juice during her third pregnancy and then was transferred to positive control during her fourth pregnancy.

The weights in grams during the first six weeks of pregnancy are given in the following graphs. The dotted line indicates the average weight in each case as calculated from the weights of the individuals.

Weight of mothers during first six weeks of pregnancy.—An examination of Graph IV shows that of those mothers which had greens as a supplement, five lost some weight during the first six weeks of pregnancy; however, in no case was there a great loss of weight and none was recorded for longer than two weeks. In all the cases except M-6 the loss might be accounted for by the

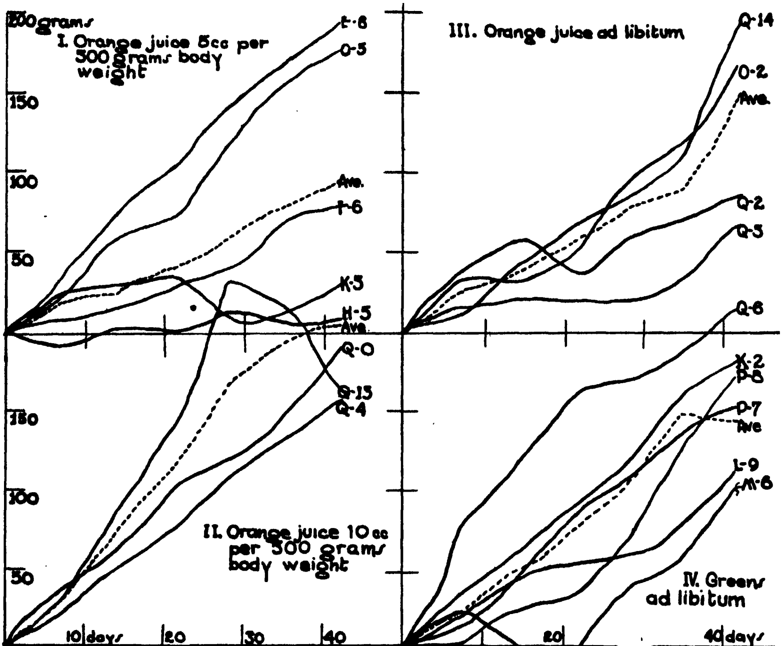

FIG. 1. Graphs showing the increase in weight of pregnant guinea pigs having the various vitamin C-supplements during the first six weeks of pregnancy.

relation of intake of food or the elimination of excreta at the time of weighing. In the case of M-6 the loss of weight continued during two successive weeks, amounting to 31 grams, which apparently was too great to be attributed to any of the causes listed above.

Of the 12 pregnant mothers which received orange juice as a supplement, four lost weight during the first six weeks of pregnancy. 0-2, which was on orange juice ad libitum, lost only 3 grams, but Q-2, on the same diet, lost 24 grams. Q-13, which was on 10 c.c. of orange juice per 300 grams body weight, lost 75 grams. This was true notwithstanding the fact that she was carrying seven embryos. K-3, which had 5 c.c. of orange juice per 300 grams body weight, lost only 4 grams which probably was insignificant.

The gain in weight during pregnancy is more striking than the loss. The average gain per month of those which had greens as a supplement was 199 +

grams, with a minimum of 52 grams for P-12 and a maximum of 358 grams for L-2. While those on orange juice averaged 137 grams, with a minimum of 7 grams for K-3 and a maximum of 208 grams for Q-14. Q-6 increased in weight constantly and at no time during the experiment did she lose weight.

Negative Controls.—Although it had been repeatedly shown that animals on the basic diet without a vitamin C supplement would lose weight and soon die, it was thought best to use one of the mothers which had been kept on greens as a supplement during her first pregnancy and her young as negative controls. Accordingly Q-8, which had accepted a male the day she gave birth to her three young, was chosen as a negative control mother, and her three young were left with her.

TABLE II.—Negative controls, mother and her young

Animal.	Weight in grams when put on experiment.	End of first week.	End of second week.	End of third week.	End of fourth week.	End of fifth week.	End of sixth week.
Mother:							
Q-8	632	600	596	477	320	....	....
Young:							
A	284 (A, B, C combined)	258 (A, B, C combined)	121	149	163	160	143
B			130	167	180	169	157
C			130	163	179	153	150

The weights of these negative controls are summarized in table II. The mother was healthy, and vigorous when she was put on the diet. The young appeared normal in every way. The mother began to lose weight at once and continued to do so. In 20 days she aborted and four days later she died in the fourth week of the experiment. She weighed 320 grams at the time of her death.

The combined weight of the young when placed on the experiment was 284 grams. At the end of the first week their weight was 258 grams. After that time each animal was weighed separately. All the young showed some gain after the first week until the end of the fourth week, but this gain was not enough to be normal. They began to lose weight and were so weak and emaciated that they were killed at the end of the sixth week.

Pregnant mothers and young on experimental diets during lactation.—All the mothers which we were able to breed after parturition were continued on some experimental diet during lactation. Table III is a summary of the weights per week for five weeks of one mother and young on greens as a supplement, one mother and young with 10 c. c. of orange juice per 300 grams body weight as a supplement and one with 5 c. c. of orange juice per 300 grams body weight as a supplement. One of the young whose mother received 5 c. c. orange juice daily died at 29 days and the other died at 31 days. That discontinued that part of the experiment. In the case of the mother and young which were placed on greens, the young as well as the mother ate the greens. In the cases of the orange juice supplement only the mothers received the orange juice. It was supplied by pipette. The only antiscorbutic vitamin which the young received was through the mother's milk. The differences of

TABLE III.—Mothers which became pregnant after parturition continued on diet during lactation

Animal.	Weight in grams beginning of experiment.	End of first week.	End of second week.	End of third week.	End of fourth week.	End of fifth week.
A. Greens as Supplement						
Mother: P-8	588	642	650	611	648	769
Young: A, B, C	298	408	601	716	933	1,074
B. Orange Juice 10 cc per 300 Grams Body Weight as Supplement						
Mother: O-2	708	724	739	805	811	869
Young: A, B, C	232	248	267	296	330	352
C. Orange Juice 5 cc per 300 Grams Body Weight as Supplement						
Mother: Q-6	720	763	843	866	950	....
Young: A, B	291	293	328	312	257	....

the effects upon the mothers were not great, but it will be seen that the growth of the young on greens as a supplement was much greater than in the other two cases. This was further manifest in the appearance of the hair and the general playfulness of the young in the cage. The young of Q-6 appeared and behaved a great deal like those with no vitamin C supplement. The young of 0-2 continued to gain in weight, but the gain was slow. At the end of five weeks the total gain was 120 grams or an average of 40 grams each as compared with the young of P-8 in which the total gain for the same length of time was 776 grams or an average of 288 grams each. This general condition was maintained for the other mothers and their young which were continued on the experimental diets.

DISCUSSION

As was stated in the review of literature guinea pigs on a vitamin C-free or a vitamin C-limited diet, usually young growing animals have been selected. Our data show that growing animals will succumb more quickly to vitamin C-free diet than older ones, also, if vitamin C is supplied sufficiently to maintain growth at all, young animals gain better than older ones.

We agree with Ingier (*9*) that vitamin C deficiency in the earlier stages of pregnancy invariably resulted in premature birth or death of fetuses. Since all the mothers became pregnant before they were put on the experimental diet, we are able to state the influence of such deficiency only in later stages

of pregnancy. We would not completely agree with Ingier, however, upon what a vitamin C deficiency is.

While Sherman, LaMer and Campbell (*12*), Key and Elphick (*10*), Höjer (*8*) and others have defined and determined the protective dose of vitamin C against scurvy, our data show that the same amount and even more is not sufficient for normal reproduction. The embryos of the mothers on orange juice alone as a supplement to the vitamin C-free diet did not develop as well as those in which greens were used as a supplement, and in no case did a mother carry her young to term on orange juice alone as a supplement at the levels at which it was supplied. When we gave orange juice as a supplement to the basic diet not less than 5 c. c. per 300 grams body weight were used because our previous work, Kramer, Harman and Brill (*11*) convinced us that we could not get living young from animals which had less than this amount. We were careful to have the animals become pregnant before being placed upon the experiment for we had found it extremely difficult to get pregnancies of mothers after being placed on orange juice as a supplement. Some of the animals which had reproduced while on greens as a supplement were changed to orange juice as a supplement in order to test whether the difference was in the individual mother or in the diet. Likewise we changed two of the mothers which had been on orange juice to greens for the same reason. Furthermore, three of the mothers which had produced a litter each while on greens as a supplement were kept on the same diet for a second pregnancy. The results indicate that it was the diet which made the difference in the reproduction and the growth of the embryos and not the inherent qualities of the individual mother.

The experiments with young during lactation indicate that it is difficult for the young to secure sufficient vitamin C from the mother's milk alone. Those mothers which received 10 c. c. of orange juice per 300 grams body weight had better and healthier appearing young than those on only 5 c. c. of orange juice. In case of the mothers on greens as a supplement the young had access to the greens as well. It could not be determined whether the better growth in these cases was due to the milk produced by the mother or to the extra greens eaten by the young or to both.

SUMMARY AND CONCLUSIONS

The data reported show that:

1. Guinea pigs on the basic diet alone did not grow nor reproduce and soon died.

2. Young postnatal guinea pigs grew and maintained the appearance of health on orange juice as a vitamin C-supplement better than older animals, also, younger ones responded more quickly to the complete absence of vitamin C in the diet.

3. Pregnant mothers on orange juice as a supplement were able in a few cases to give birth to living young. The parturition was always premature and the young did not live long.

4. Orange juice at the levels used was not a sufficient supplement to this standard vitamin C-free diet for reproduction and birth of living, healthy, full-term young guinea pigs. Normal growth and reproduction was secured when this vitamin C-free diet was supplemented with greens.

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An Anomalous Lamb

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In the early spring of 1935 the junior author found in his flock of sheep a male lamb which had been born with only three legs. It was dead when found, probably not more than an hour after delivery. It was one of a pair of twins; the other member, a female, was entirely normal to all appearances. The male twin, upon closer examination, showed a number of abnormalities which appear to be rather striking, and are described in this paper.

DESCRIPTION

External features.—The animal had developed to full term and appeared to be average in size. Actual measurement from head to rump was somewhat shorter than normal, because of an excessive curvature of the spinal column. The size of the head and the length of the limbs were those of a normal lamb at time of birth. The head showed marked asymmetry in that the nose from immediately below the eyes was deflected to the left, and the right eye was raised above the left, and slightly more cephalad in position. There was no right foreleg and no skin on a large part of the right side of the body. This area was covered with a very thin soft membrane consisting of the pleuroperitoneum and fasciae and a few scattered muscle bundles. Near the mid-dorsal line was a tonguelike pouch, measuring 3.5 cm. in length (see arrow in Plate I, fig. A). This diverticulum seemed to be roughened with numerous short villi. The purpose of this structure could not be ascertained as it was not connected directly with any other system. A short distance cephalad to this structure was a small opening which led into the esophagus (Plate II, fig. F, Oe). In the more caudad portion of this area the abdominal wall was folded closely over the viscera. The normal skin contained a good growth of wool, of normal length and texture. On the side of the right hind leg the skin had formed two slender pouches similar to scrotal sacs, but much smaller and without any lumen. The tail was of normal length and the normal scrotal sacs were in their usual position. An anus was absent.

Musculature.—No detailed study of the individual muscles was undertaken. The muscles of the limbs were firm and poorly developed, which is correlated with a complete absence of all spinal nerves. The membrane covering the exposed part of the body contained a few muscle fibers. The head showed much better muscular development than the other parts of the body.

Skeleton.—The skeleton showed very marked abnormalities and omissions as is evident from the X-ray photograph (Plate I, fig. B). Rather rigid ankylosis at all articulations of the limbs must have resulted in some dystocia. The right half of all vertebrae was absent, with the exception of those of the third and fourth sacral and the caudal vertebrae, thus failing to form a neural canal. The spinal processes of the left portion of the cervical vertebrae were upright in position, but those of the thoracic and lumbar vertebrae were deflected over to the left (Plate II, fig. B). The processes of the vertebrae $T_1 = T_9$ and of $T_{11} = L_4$ were fused into two compact structures, respectively. The atlas was small, completely lacking an articular surface for the occipital condyle. The articulation on the left side took place on the upper portion of

the second cervical vertebra, or axis. Immediately above this articular surface was a part of the neural arch which fitted over the base of the brain and articulated with the right occipital condyle (Plate II, fig. A, na). The centra of vertebrae C_7, T_{10}, T_{14}, L_1 and L_2 were smaller than the others, or entirely absent, and the spinal column was sharply flexed at these points, even as much as ninety degrees. There was also a dorsal arch produced by the last lumbar and the first two sacral vertebrae. The left ilium of the pelvic girdle was attached in its normal position to the sacrum, but the right ilium was out of its position, evidently due to the absence of the right half of the first two sacral vertebrae. A right sacrum, evidently the third vertebra, was present and was fused on the ventral side with both the second and third of the left side. With the appearance of the right half of the vertebra there was also the formation of the neural arch and the neural canal, although the entire structure was greatly flattened dorsoventrally (Plate II, fig. C). The caudal vertebrae were all complete and normal. Fourteen ribs were present on the left side, all of which seemed to be normal in structure, although somewhat displaced in the region of the tenth vertebra. The sternum consisted of two bones, the anterior one being much smaller than the posterior one. The left ribs were attached to these two bones as indicated by $R_1 = R_9$ (Plate II, fig. D). The skull bones all seemed to be completely formed although in some cases considerably malformed. The mandible was normal. A posterior aspect of the skull showed a greatly distorted and asymmetrical occipital bone, giving a twist to the foramen magnum (Plate II, fig. E). Only the left condyle was well developed, the right one showing up only as a small prominence.

Digestive system.—The first abnormality in the anterior part of the digestive tract was a small pore in the esophagus which led to the outside through the thin covering in the region of the mid-thorax. After passing through the diaphragm the digestive tract expanded into a rather large, loose bag representing the stomach. It failed to show the four pouches characteristic of stomachs of ruminants. At the posterior level of the liver this bag narrowed down to about 2 cm. where it opened directly into the coelom. The rest of the digestive tube was entirely absent. Immediately below the stomach and to its right was a much laterally compressed liver which showed a simple lobing on the ventral side. A gall bladder and bile duct were absent. Posterior to the liver was a fairly large ovoid pancreas showing no further connection with the rest of the digestive system except by a small mesentery.

Circulatory system.—The circulatory system showed peculiar derangement and absence of parts (Plate II, figs. G and H). The heart was normal with the exception of lateral flattening. The right subclavian artery, which should lead to the right leg, was normal in its place of branching from the anterior aorta but led into the musculature of the neck below the point of branching. The left subclavian artery, instead of coming off the anterior aorta, branched from the aortic arch about 1 cm. caudad to the division of the anterior and posterior aortae. It then proceeded normally into the left leg. The left renal artery and vein appeared in their normal positions, but those going to the right kidney branched from the aorta and the inferior vena cava 6 cm. more caudad. No trace of the coeliac axis and the mesenteric arteries could be found, and the hepatic portal vein was absent also. The right and left iliac, umbilical, and sacral arteries were not paired as they should be, but the

left group branched from the dorsal aorta 2 cm. cephalad to the right group. The carotid arteries were normal. The hepatic vein, after receiving the umbilical vein, extended from the liver through the diaphragm to the heart where it entered the right atrium at the base of the posterior vena cava. The right and left iliac veins arose 2 cm. from each other.

Respiratory system.—The trachea and left lung were normal in size and structure. The right lung was only approximately one fourth its normal size and greatly compressed.

Urogenital system.—(Plate II, fig. F.) The left kidney, which appeared to be quite normal in shape and size, was lying immediately caudad to the diaphragm and somewhat dorsal to the stomach. From a lateral aspect it appeared to be lying above the vertebral column. It had its usual connections with the circulatory system. The ureter extended caudally to the bladder and entered it in its normal place on the left side. The right kidney was lying in the pelvic region and was subtriangular in shape with a groove on one side. Its ureter was short, being directed anteriorly and ventrally to the bladder. The bladder was a large, loose bag connected on the ventral side with the umbilicus and dorsally terminating in the urethra, which passed through the pelvis and then into the well-formed penis. The scrotal sac was well-developed, but neither one of the testes had descended into it. The right testis was ventrad and caudad to the urinary bladder in position. It was small in size, being about one half as long and one fourth as thick as the left testis. The left one, which was lying in the mid-abdominal region above the bladder and immediately behind the pancreas, appeared to be developed normally. The right vas deferens was about 4 cm. in length, passing into the seminal vesicle and prostate gland above the bladder at the base of the urethra, whereas, the vas deferens from the left testis was only about 1 cm. in length before it entered the seminal vesicle and prostate gland on the left side.

Nervous system.—As far as could be ascertained the brain was normal in development. The cranial nerves were present, the vagus extending to the thoracic and upper abdominal viscera. The cerebellum and medulla oblongata projected partially through the twisted foramen magnum. The spinal cord and spinal nerves were absent, the central nervous system ending abruptly at the level of the second cervical vertebra.

GENERAL DISCUSSION

Williams (1931) in his publication on teratology summarizes the more important cases of monstrosities of domestic animals known, and gives seventeen cases of his own, only one of which is from a sheep. Bovine monsters are in preponderance, with ovine coming second. The one described in this paper is similar in certain respects to some of those mentioned by Williams, but it is unique in the particular combination of absences and malformations in the systems or parts of systems. The complete absence of the spinal cord, the right half of the vertebrae, right ribs, and the right foreleg, as well as the muscles on the right half of the body, seems to indicate a failure in the formation of that part of the neural tube and the myotomes of the embryo which normally give rise to these structures. Factors responsible for such monstrosities have been discussed by Williams and will not be entered into in this paper.

SUMMARY

In an anomalous male lamb born at full term the right foreleg, pectoral girdle, right half of vertebrae C_1 to S_2 and their processes, the spinal cord with its nerves, and the digestive system beyond a simple stomach, were all completely absent. The musculature of trunk and limbs were poorly developed. The skeletal system was grossly deformed and visceral organs displaced. The hepatic portal, coeliac axis, the mesenteric arteries were lacking and the right iliac trunks, renals and left subclavian vessels were out of their normal position.

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PLATE I

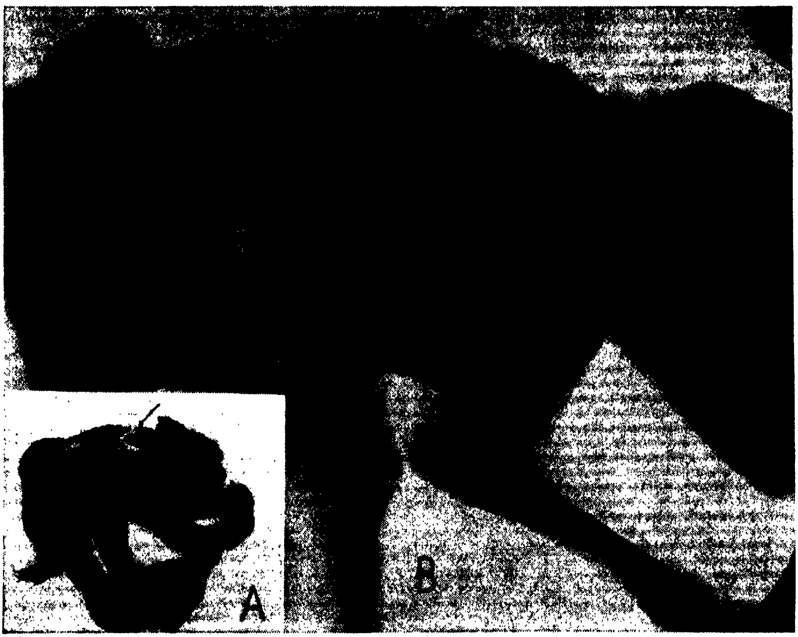


Fig. A. Photograph of lamb, right side. Arrow points to diverticulum of the thin body wall. (Photograph by G. Lawrence Gill).

Fig. B. X-ray photograph showing complete absence of right pectoral girdle and right ribs, and spinal curvatures. (Photograph by Dr. Marion Trueheart).

PLATE II

FIG. A. Vertebral column, right aspect. Ar, articular surface for occipital condyle; C_1-C_7, cervical vertebrae; Ca, caudal vertebrae; Li, left ilium; L_8-L_6, lumbar vertebrae; na, neural arch; Ri, right ilium; S_1-S_3, left sacral vertebrae; S_3r, right sacral vetrebra; T_1-T_{13}, thoracic vetrebrae.

FIG. B. Posterior view of ninth thoracic vertebra and rib. R_9, left rib; Ce, centrum; Sp, spinal process.

FIG. C. Anterior view of sacrum. Nc, neural canal; S_2, left sacral vetrebra; S_3r, right sacral vertebra.

FIG. D. Sternum, ventral aspect. R_1-R_9, position and place of attachment of left ribs.

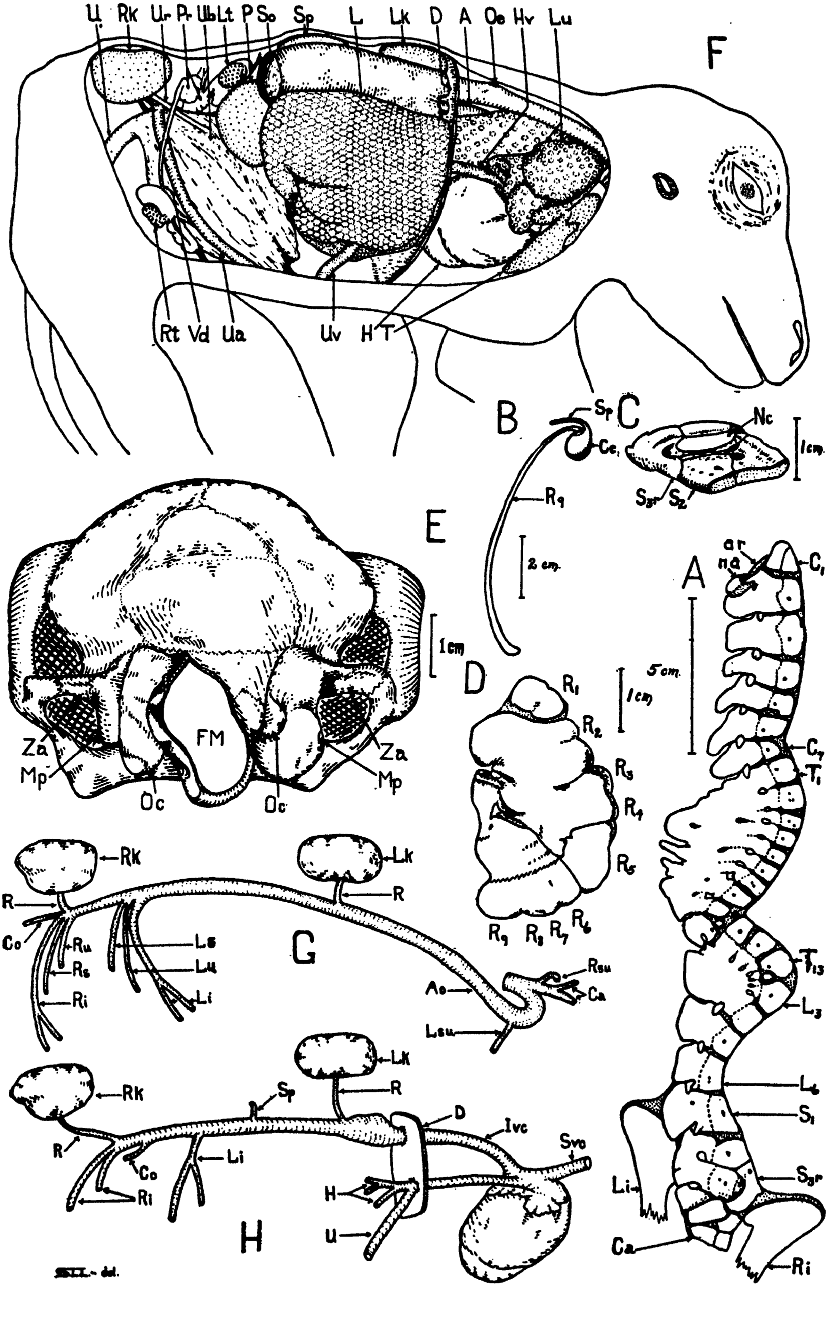
FIG. E. Skull, Posterior aspect. FM, foramen magnum; Mp, mastoid process; Oc, occipital condyle; Za, zygomatic arch.

FIG. F. Pleuro-abdominal viscera, right lateral aspect. A, aorta; D, diaphragm; H, heart; Hv, hepatic vein; L. liver; Lk, left kidney; Lt, left testis; Lu, lungs; Oe, esophagus; P, pancreas; Pr, seminal vesicles and prostate gland; Rk, right kidney; Rt, right testis; So, stomach; Sp, spleen; T, thymus gland; U, urethra; Ub, urinary bladder; Ua, umbilical artery; Ur, ureter; Uv, umbilical vein; Vd, vas deferens.

FIG. G. Arterial system. Ao, aorta; Ca, carotids; Co, coccygeal; Li, left iliac; Lk, left kidney; Ls, left sacral; Lsu, left subclavian; Lu, left umbilical; Ri, right iliac; Rk, right kidney; R, renal; Rs, right sacral; Rsu, right subclavian; Ru, right umbilical.

FIG. H. Venous system. Co, coccygeal; D, diaphragm; H, hepatic; Ivc, inferior vena cava; Li, left iliac; Lk, left kidney; R, renal; Ri, right iliac; Rk, right kidney; Sp, splenic; Svc, superior vena cava; U, umbilical vein.

PLATE II



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B
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2 cm.
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FM
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5 cm.
C7
T1
T13
L3
L6
S1
S3r
Li
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1 cm
R1 R2 R3 R4 R5 R6 R7 R8 R9
G
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Lk
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Some Reactions of Naegleria bistadialis to Light Intensity Patterns

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INTRODUCTION

The term tropism was first used by De Candolle in 1935 to describe the bending of a plant toward a light source.[1] The term has been used constantly since by workers in the field of the behavior of simple organisms, both plant and animal. As one peruses the literature, he is struck by two facts concerning the concept of tropistic response:

First, what was to De Candolle and his contemporaries a purely descriptive term for a simple reaction has become an almost explanatory term for increasingly complex reactions until in some cases tropisms are spoken of as though they were vitalistic causes of behavior, itself.

In the second place, despite the increasing complexity and even ambiguity of the concept, there are types of behavior which have no meaning whatever in terms of tropisms. Because the tropistic concept assumes the organism as reacting to impinging physical forces external to it, the concept has no meaning in either describing or explaining three readily observable types of behavior. First, organisms respond to relative intensities of stimulation and not to absolute intensities as might be expected. Secondly, even the simplest forms show some adaptation or adjustment to repeated, stimulating situations which, without misuse of the term, may be called learning of a simple order. Thirdly, any observer knows that a very large part of the behavior of simple animals, especially, is apparently entirely spontaneous and unprovoked by either natural or experimental stimulation.[2] Hence the question arises, how important are these nontropistic responses, and, if significant, is there not some explanatory concept of simple behavior which will make meaningful these reactions as well as those more or less satisfactorily explained or described as tropistic responses? The following paragraphs of this paper shall briefly summarize some research which seems to point an answer to this question.

PROCEDURE

The organism used in this investigation was *Naegleria bistadialis*,[3] a small amoeba considered to be, phylogenetically, the lowest of the true lobose rhizopoda.[4] A rich culture was established and continued over a period of months by a method of simple closed dish culture.[3]

All studies were made through a Spencer Research No. 3 microscope with interchangeable body, carrying 10x oculars and four objectives of which the 16 mm. was used for these studies. The same 52 x 76 mm. slide of low refractive index was used in all studies. Illumination was secured by an E. Leitz

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25—2077

Wetzlar, Mignon type substage lamp equipped with a 11.5 volt, 6 amp. Mazda bulb and a Jerrerson step-down transformer with double secondary giving either 12 or 6 volts from the 110 volt a. c. main. All light was passed through the regular Spencer substage carrying an Abbe achromatic condenser N. A. 1.40 in which was placed a water cell of 5 mm. internal dimension completely filled with triple distilled water. All light patterns subsequently mentioned were obtained by placing screens made of twelve pound bond paper of one or more layers just outside the object lens of the lamp. These layers of paper were not pasted or glued together. The patterns so formed, were focused by the adjustable substage condenser upon the upper surface of the slide upon which the organisms were being observed. In the second and third divisions of this experiment the positions of the organisms with respect to the pattern was recorded through a Bausch and Lomb, No. 1620 Abbe camera lucida so that no subjective estimate of the observer was involved.

Room temperature during these experiments varied from 68 to 96 degrees F.

All light was excluded from the organisms being studied, except the experimental light passing through the screen and condenser. This was accomplished by working in a darkened room and mostly at night and, as a further precaution, by a cone of opaque, black cardboard attached to the objective and lowered in an inverted position over the culture drop.

Under these conditions all organisms studied were reacting to light only as it approached them from below through the patterned diaphragm and further the various areas of the pattern were in no sense sources of stimulation, but merely regions of greater or less intensity of the common source where line of illumination was perpendicular to the plane of the substrate on which the organism moved.

DATA

PART I.—TRANSPOSITIONAL RESPONSES

For the first group of experiments, the diaphragm was laid off into four zones of intensity parallel to each other. For the first or highest intensity, light was passed through a single thickness of paper; for the second intensity, through two thicknesses and so on to dimmest zone where the light was passing through four layers of paper. The position of the light was so adjusted that three zones just filled the field of the scope. By a slight movement of the substage mirror it was possible to remove one extreme zone and bring on the other extreme at the opposite side of the field.

It was known before these experiments were begun that in a differentially illuminated field, Naeglaria tends to choose a region of medium intensity. The procedure was to place a culture of several organisms on the slide, turn up the pattern, wait 2½ minutes, count the distribution of organisms in the intensity zones, wait 2½ minutes, change the field structure by removal of the low or high extreme and substitute the other, and after 2½ minutes count the distribution in the new intensity zones. In some cases the slide was moved with the change of pattern, in other cases not. Such movement had little effect. The outstanding result was that the greater part of the organisms studied chose the medium intensity regardless of its actual intensity value and made their transposition to the comparable region. Of 1,603 organisms so studied over a period of 22.4 hours, only 97 did not transpose, and of these only 23 moved in the direction opposite to expectations.

Part II.—Turning Reactions to Remote Barriers

For the second group of experiments the diaphragm was so made as to have a bright zone at one side of the field and the remainder and greater part of the field a uniform intensity. The bright zone (hereafter spoken of as the barrier) was made of a single layer of paper; the remainder of the field, of three layers.

The procedure was to locate a single, moving organism, raise the pattern and by rotating the screen, place the barrier directly in its path. The amoeba would move up almost to the barrier (never entering it) and then turn right or left. After its new course was established the organism would be placed more centrally in the field and the barrier once more rotated to block its path. And so on. The position of the organism was traced by camera lucida at five-minute intervals and always with respect to the barrier.

Twelve experiments like this were made, in which organisms were forced to turn a total of 100 times over a period of 83.6 hours during which 1,094 tracings of their positions were made.

From data so recorded, two facts are worthy of our notice. First, adjustment was always made at some distance from the barrier, and, secondly, this distance became increasingly greater with repetition of the experience by the same organism.

Part III.—Vectoral Behavior

The paths of Naegleria in Part II suggested that interesting results might be obtained if two or more barriers were used. First a screen was made exactly as in Part II except that a second barrier was laid off similar in size and intensity at right angles to the first. Thus a V was formed, between the arms of which lay a neutral field. Paths were studied when the organism was forced to move toward the apex of this V and turn before moving toward the unobstructed side of the field and also when the field was so turned that their paths began high in the apex and again led toward the side lacking a barrier. The striking fact, when the tracings of these paths were later studied, was how nearly in both cases, and especially the latter, they coincided with a line that might be drawn to divide the neutral zone and be equidistant at all points from the barriers.

To test this a screen was made similar to the preceding except that the barriers were of different intensity. Here a line representing a vectoral value of the two barrier intensities would fall to the side of the lesser intensity. Experiment showed the paths of Naegleria to do exactly that, also.

A third modification of these barrier patterns was tried by completely surrounding a neutral field with three barriers of much higher intensity. As might be expected an organism placed in the neutral zone followed a somewhat spiral path and finally ceased forward movement at roughly the center of the neutral zone. When these barriers were all of different intensity, the point of cessation of forward movement was roughly the centroid point of the three barrier intensities.

CONCLUSIONS

From these experiments certain, at least tentative, conclusions seem warranted.

1. Response of Naeglaria under these conditions is not to absolute intensities, but to relative intensities of quite wide differences.

2. Reaction is not to isolated points of stimulation which impinge upon the organism in an external sense but rather is the reaction to a total pattern, to a dynamic field of influence of which the reacting organism is, itself, a part.

3. Naegleria, under these conditions, does learn at least to the degree of making more prompt and adequate adjustment to a repeated situation.

4. Since mention was made earlier of spontanecus behavior a word concerning it that may be drawn from these experiments may not be amiss in conclusion. If behavior with respect to light is in terms of dynamic fields of influence, it is not impossible that many such fields beyond control or notice of the experimenter are constantly determining behavior regardless of how carefully the experimental situation be controlled. Such view would account for all facts of tropistic response as well as those which the concept of tropisms seems unable to explain. Much further work needs to be done from this dynamic point of view.

Endometrial Hyperplasia as Observed in Experimental Guinea Pigs[1]

OLGA SAFFRY, MARY T. HARMAN, and MARTHA M. KRAMER,
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Endometrial hyperplasia has been observed in the laboratory in guinea pigs receiving limited amounts of vitamin C. The condition is similar in appearance to cases reported by various workers, found in human uteri and in experimental guinea pigs, rats, and mice which had been injected with estrogen. Injections of estrogen cause an unbalance in the hypophyseal-ovarian relationship which may result in an irregular or prolonged oestrous period, and in a definite change in the histological picture of the endometrium, the mucus membrane that lines the cavity of the uterus. The most striking characteristic is the cystic dilation of the mucus glands of the endometrium.

The guinea pigs examined received the standard vitamin C-free diet of Sherman, LaMer, and Campbell. One group received no supplement, but served as negative controls, while others received supplements consisting of orange juice, tomato juice, ascorbic acid (crystalline vitamin C sold as "Cebione" by Merck) and greens, fed at different levels.

In those receiving no vitamin C supplement, endometrial hyperplasia was observed, presenting a definite pattern. The glands were greatly dilated in many cases, but not uniformly. In none of the dilated glands was there atrophy of the epithelium. The epithelial lining of the glands was high, columnar, and pseudo-stratified. The cells of the stroma were small and shriveled, and, although there were spaces between the cells, edema was only slight. The glands were usually large and numerous, often containing secretions or coagulated serum. Frequently they showed the beginning of disintegration.

Animals that received 3 ml. tomato juice per 300 grams of body weight became pregnant, but aborted after 22 to 41 days of pregnancy. Examination of the uterine tissue of these animals showed endometrial hyperplasia of varying degree.

Some animals have been examined which had received ascorbic acid at a rate corresponding to 5 ml. orange juice per 300 grams of body weight. None examined had become pregnant although copulation had taken place. Tissues all showed some degree of endometrial hyperplasia. Female guinea pigs receiving 5 ml. tomato juice per 300 grams of body weight aborted and were found to have endometrial hyperplasia.

Pregnant animals on a normal diet served as positive controls. The endometrium of the animals, in contrast to those showing hyperplasia, contained small glands in which there was no dilation although the opening sometimes could be seen. The epithelial cells were high columnar, and stratified, and the stroma edematous.

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1. Contribution No. 154, Department of Zoölogy and No. 66, Department of Home Economics, Kansas State College.

Endometrial hyperplasia, previously associated with unbalance of hypophyseal-ovarian relationships and produced experimentally by injection of estrogen, has been observed in tissues of guinea pigs which received limited amounts of vitamin C. The negative control animals, fed the vitamin C-free diet alone, showed the condition in severe form while positive control animals had normal uterine tissue.

Study of a Small Prairie-dog Town

THEO. H. SCHEFFER, U. S. Biol. Survey, Puyallup, Wash.

Some years ago we had the opportunity of spending the greater part of the month of October in daily contact with the activities of a small colony of prairie dogs, in the upper Solomon Valley in Kansas. Our observation post for closeups was so near the town limits of the leisurely busy rodents that, screened from view, we lived quite among them with an opera glass as they enacted the seasonal drama of their lives under the light of a mellow, autumn sun.

The colony occupied approximately twenty acres of closely cropped bluestem and buffalo grass. For the rodents the pasturage was excellent and all seemed to be fat, in fine condition for wintering. Close observation with the glass on numerous occasions showed that they were feeding mainly on the most nutritious parts of the buffalo grass, apparently the long trailing stems with knots or nodes at short intervals. When feeding they search about carefully, and sit up at intervals to eat the vegetation they have selected. In this position they manipulate the grass stems deftly with their front feet, and are able at the same time to keep an eye out for their neighbors, as well as the apparition of a soaring hawk or skulking coyote. In this feeding practice one may note that their ancestors have handed down successively to the more canny of the tribe a greater expectancy of life.

As the nights were frosty at this season, the prairie dogs did not usually appear from their burrows until the tang of the morning was gone—in greatest numbers around ten o'clock. At the noon period fewer were abroad, but in late afternoon, maximum numbers fed or played about in the haze of windless hours.

By careful count the number of burrow openings on this prairie-dog townsite was found to be 334, or about seventeen to the acre. This was the number of open holes, and all were apparently used, at least at times. In addition there were fifteen holes that had been plugged or filled, and were therefore not in use. It may be noted here that a few of the burrows were located on the edge of an old cultivated field gone to weeds, and that, as the habit is with prairie dogs, all sunflowers and other tall plants had been cut down or prevented from growing within the "city limits." Again we recognize the survival of instincts tending to greater safety with an open view.

By dividing the colony site into three sections and counting, with the aid of the field glass, seventy prairie dogs were observed feeding at one time between 3 and 5 p. m. The next day between 9 and 11 a. m. eighty of the rodents were observed in the same territory. Additional counts on other days failed to indicate a larger population. Counting the number taken alive there in late summer by flooding a few burrows at one corner of the townsite—eleven—and a few known to have been shot by the owner of the premises, the total population of the prairie-dog town on the first of September must have been very close to 100—an average of five to the acre, one to every 3⅓ open holes. A few cases were noted where four to six animals, young and old, were still occupying a single burrow.

While engaged in feeding, the prairie dogs have a curious habit of rising on their hind legs now and then to stretch neck and paws as in an attitude of yawning, uttering at the same time a peculiar whistling call. The act seems to be contagious, passing from one to the other, though there is no appearance of excitement or alarm.

In the usual association with prairie-dog villages, about twenty burrowing owls (*Speotyto cunicularia*) claimed this townsite as their abiding place. Whether merely tolerated by the rodent builders of the colony, or living with them in mutually beneficial relations, there was at least no conflict of beak, claw, or opinions among them. At any rate, the owls may be observed in nesting season to occupy the entrances to unused prairie-dog burrows, and the rodents at any season will sit up and take notice when they hear the alarm call of the vigilant birds. The third party to an alleged mutual benefit association, the rattlesnake, was not observed about this prairie-dog colony—too late in the season, perhaps, or, more likely, too close to human habitation. But, later, several toads were discovered in the excavations, two of them in packed earth at a depth of seven feet below the prairie sod. Others had been flooded out earlier in the season by pouring water into some of the burrows.

In an attempt to demonstrate possible underground connections between burrows having apparently unit entrances at the surface, a telescoping pump was used to force the smoke of burning rags and hay into the passageways, through the partially sealed openings of such burrows. In each of ten trials, in different parts of the field, with three to seven burrow entrances at distances of ten to thirty feet from the point of operation in the several experiments, no smoke could be seen issuing from a burrow other than the one being worked. Here it kept crowding out where the earth had been packed around the discharging tube of the smoker. It may be noted here, however, that once, when flooding out the few live prairie dogs already mentioned, water issued from two holes other than the one into which it was being poured.

It may be of interest to record the weights of four adult prairie dogs taken at the close of these observations, as respectively 919, 861, 967, and 851 grams. Three young of the season weighed, respectively, 704, 722, and 659 grams.

In the closing days of the observations one burrow was excavated as fully as was practicable under the conditions presented, and several others were explored down to the horizontal drift. In the latter, partial explorations, two types of burrow trends from the surface were manifest—one descending gradually at a uniform slope, either in a nearly straight course or somewhat spirally, to gain gradient in a shorter horizontal distance. The other type sloped but two or three feet, to a vertical drop of five to seven feet. At the connection of this short entrance slope with the vertical descent there is always an enlarged vestibule or turning bay, where the animal may reconsider its alarm and return to the surface for another look.

The open burrow more fully excavated, and a packed one closely associated with it, were both of the steep gradient type with turning bay. The open burrow was fumigated with carbon bisulphide an hour or so before the work of digging was undertaken, so that possible occupants would not change location as the work proceeded. This burrow had the usual mounded entrance several inches high for a watch tower and for diking purposes. The entrance descended with little curving for about three feet, where the turning bay was

reached at a vertical depth of two feet. From here the burrow dropped almost vertically to a depth of eighty-five inches from the surface. It then sloped off 2.5 feet to its greatest depth 5 inches lower. At this point it curved sharply to one side and ran horizontally and in a direct line for 8.7 feet to the first enlargement or chamber. This was about fifteen inches in horizontal diameter and nine inches high—floor to ceiling. It contained no nesting material, but in it were three adult prairie dogs, suffocated by the carbon bisulphide treatment. This terminated the open part of the burrow, about 21 feet from the entrance and 7.5 feet from the surface.

From one side of this chamber of ultimate retreat for the animals, a packed connection about a foot in length led to a second and larger chamber, 14 $\times$ 19 inches horizontally, and ten inches from floor to ceiling; this also packed with partially rotted nesting material, crumbling pellets of excrement, and some earth. From the side of this packed chamber farthest from its connection with the first chamber led another packed burrow, which was excavated and probed to a distance of 4 feet only. Also, from a point on the short connection between the two chambers, a third lateral or continuation of an older burrow took a curving course of 8.5 feet to an enlargement. This burrow was packed with yellowish earth for its entire length. The enlargement was not in the nature of a chamber, as the other two, but rather a retort-shaped pit about ten inches in diameter and eighteen inches deep, filled with old excavated earth. From its highest vertical point the old burrow continued with a gentle upward slope, probably to the surface somewhere. It was not excavated beyond three feet from the filled pit.

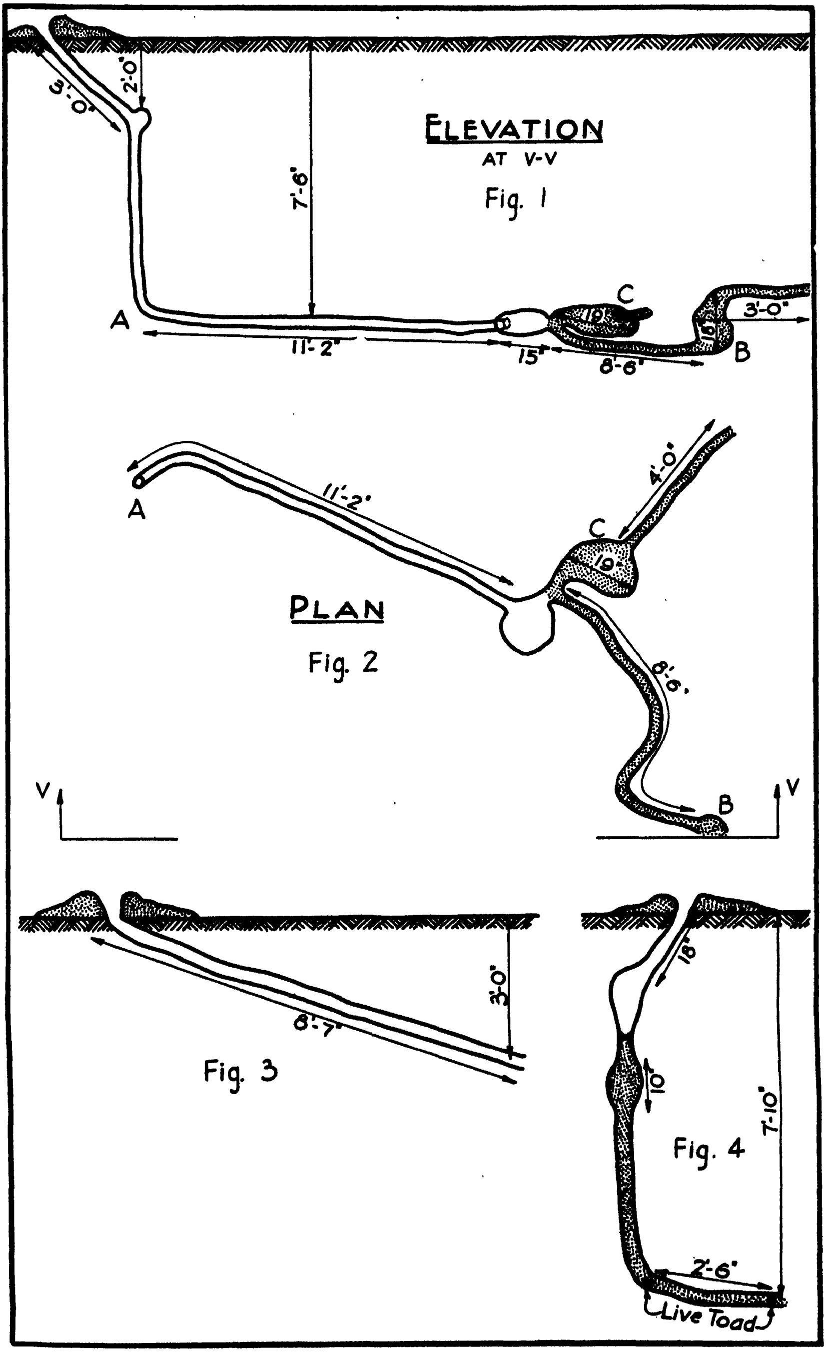
In no part of any burrow excavated was there evidence that food supplies had been stored at any time. The prairie dog in this district hibernates only in the stormier periods of winter, and may be seen out on sunny noons even in freezing weather.

PLATE I

Fig. 1. Elevation sketch, and (Fig. 2), horizontal plan of a partly excavated burrow system in a colony site of the prairie dog, on upland pasture, central Kansas. "A." Open, used part of the burrow system, ending in a chamber 21 feet from the entrance and 7½ feet beneath the prairie sod; "B" and "C," older parts of the burrow system—chambers, and burrows once leading to the surface; these now packed with refuse and earth. Fig. 3, the gradually sloping type of burrow, either straight or in spiral turns (only partly excavated). Fig. 4, one of the type of vertically-descending burrows, with turning bay near the surface. Beneath the latter the burrow was packed with earth as far as it was followed in excavation.

Parts of the burrow system represented by shading in the sketches are packed with refuse and earth.

PLATE I


ELEVATION
AT V-V
Fig. 1
3'-0"
2'-0"
7'-6"
A
11'-2"
15"
C
19"
16"
8'-6"
B
3'-0"
PLAN
Fig. 2
A
11'-2"
4'-0"
C
19"
8'-6"
B
V
V
Fig. 3
3'-0"
8'-7"
Fig. 4
18"
10"
7'-10"
2'-6"
Live Toad

Summer Birds of Rawlins County, Kansas

OTTO W. TIEMEIER, University of Kansas, Lawrence, Kan.

During the week of July 27 to August 1, 1936, a party from the University of Kansas Museum of Birds and Mammals collected specimens on Beaver creek, two miles northeast of Ludell, Rawlins county, Kansas.

Beaver creek, in the region studied, is fairly well timbered. The brush along the banks in many places was impenetrable. The vegetation bordering the creek was surprisingly heavy and green, considering the extreme heat and drought of the summer, and the ravenous appetites of the grasshoppers. Only small scattered pools of water remained in the stream bed. During the week of collecting at this locality the fish were dying by the hundreds.

The present list includes several forms, such as the black-billed cuckoo and the rose-breasted grosbeak which were found in this region. In Kansas they have been previously considered as restricted to the eastern part of the state.

1. *Buteo swainsoni*, Swainson's Hawk. The most common summer hawk of western Kansas. They were seen in abundance along the roadsides and in trees along small timbered ravines. Specimens examined were found to be gorged with grasshoppers.

2. *Buteo regalis*, Ferruginous rough-leg. Common.

3. *Colinus virginianus virginianus*, Eastern bobwhite. Fairly common. The bobwhite could be heard nearly every morning near our camp.

4. *Phasianus colchicus torquatus*, Ring-necked pheasant. Common. These birds were thriving in this region under the protection of the landowners. Several large coveys were flushed along the timbered creek.

5. *Oxyechus vociferus vociferus*, Killdeer. Common along the small ravines.

6. *Zenaidura macroura marginella*, Western mourning dove. Common.

7. *Coccyzus americanus americanus*, Yellow-billed cuckoo. Common.

8. *Coccyzus erythrophthalmus*, Black-billed cuckoo. Fairly common. Three specimens were taken. Collectors from the University of Kansas Museum had never before taken this bird in western Kansas. These birds are rare in eastern Kansas. In twenty years of collecting only six specimens have been taken in Douglas county.

9. *Tyto alba pratincola*, Barn owl. Common. Several specimens were taken during the week of collecting.

10. *Otus asio aikeni*, Aiken's screech owl. Fairly common. One immature specimen was taken July 28.

11. *Bubo virginianus occidentalis*, Montana horned owl. Common. Two specimens were taken July 31. These have been referred to the above subspecies. They are darker than specimens from Hamilton county which have been designated *pallescens*.

12. *Megaceryle alcyon alcyon*, Eastern belted kingfisher. Fairly common. One specimen was taken and several more were seen along the creek on which we collected.

13. *Colaptes auratus luteus*, Northern flicker. Fairly common.

14. *Melanerpes erythrocephalus*, Red-headed woodpecker. Common. Several immature, as well as mature specimens, were taken.

15. *Dryobates villosus villosus,* Eastern hairy woodpecker. Common.

16. *Dryobates pubescens medianus,* Northern downy woodpecker. Common.

17. *Tyrannus tyrannus,* Eastern kingbird. One specimen was taken July 29.

18. *Empidonax minimus,* Least flycatcher. This little flycatcher was very common. They were often seen feeding with chickadees and vireos.

19. *Riparia riparia riparia,* Bank swallow. Commonly seen along the banks of the creek.

20. *Hirundo erythrogaster,* Barn swallow. Common. Nested in the barns and buildings around farmhouses.

21. *Cyanocitta cristata cristata,* Northern bluejay. The bluejay was one of the most common birds in this locality. Hundreds of these noisy birds quarreled and chattered continually in the trees. Both mature and immature specimens were taken.

22. *Pica pica hudsonia,* American magpie. Several specimens were taken about two miles north of Ludell. Farmers told us that they were quite numerous in certain restricted localities.

23. *Corvus brachyrhynchos brachyrhynchos,* Eastern crow. Very common. Hundreds flocked to the cottonwood trees along the creek every evening.

24. *Penthestes atricapillus septentrionalis,* Long-tailed chickadee. Chickadees were common, flitting about among the trees and underbrush. It was interesting to watch one of these tiny birds clinging to a low branch pecking away industriously upon a large grasshopper.

25. *Troglodytes aedon parkmani,* Western house wren. Very commonly seen dodging among the roots of the trees along the banks of the creek.

26. *Mimus polyglottos leucopterus,* Western mockingbird. Several specimens collected have been referred to this subspecies on the basis of coloration. They are lighter in color than birds from eastern Kansas.

27. *Dumatella carolinensis,* Catbird. One specimen was collected. It was the only one seen in the entire week of collecting.

28. *Toxostoma rufum,* Brown thrasher. Common. The brown thrashers were commonly associated with grosbeaks in the thick brush along the creek.

29. *Vireo belli, belli,* Bell's viero. Common.

30. *Icteria virens auricollis,* Long-tailed chat. Common. A number of specimens of the above were taken. They were commonly seen feeding on the ground or in the bush. Both mature and immature specimens were taken.

31. *Passer domesticus, domesticus,* English sparrow. Common around the farm buildings.

32. *Sturnella neglecta,* Western meadowlark. Abundant in pastures and weed patches.

33. *Icterus spurius,* Orchard oriole. Least common of the three species of orioles found in this region.

34. *Icterus galbula,* Baltimore oriole. Fairly common.

35. *Icterus bullocki,* Bullock's oriole. Common.

36. *Quiscalus quiscula aeneus,* Bronzed grackle. Common.

37. *Molothrus ater ater,* Eastern cowbird. Common. Several specimens have been referred to the above, but they appear to be intermediate with the above and *artemisiae.*

38. *Richmondena cardinalis cardinalis,* Eastern cardinal. Fairly common.

One specimen was collected and several more were observed. We could hear them singing from the brush and trees every morning.

39. *Hedymeles ludovicianus,* Rose-breasted grosbeak. Rare. Only one specimen of this beautiful grosbeak was collected and it was the only one observed.

40. *Hedymeles melanocephalus papago,* Rocky mountain grosbeak. Common. A number of these grosbeaks were taken. The rose-breasted is a bird of the tree tops, while the present species was always observed in the low branches and in the heavy brush. Both mature and immature specimens were taken.

41. *Guiraca caerulea interfusa,* Western blue grosbeak. Common. Four specimens were taken and a number more were observed.

42. *Spiza americana,* Dickcissel. Common.

43. *Chondestes grammacus strigatus,* Western lark sparrow. Common. The lark sparrow could often be seen in pastures and stubble fields.

Other species from Rawlins county represented by specimens in the University of Kansas Museum collection included the following:

Catoptrophus semipalmatus inornatus, Western willet.
Chordeiles minor howelli, Howell's nighthawk.
Sayornis saya saya, Say's phoebe.
Salpinctes obsoletus obsoletus, Rock wren.
Calamospiza melanocorys, Lark bunting.
Ammodramus savannarum bimaculatus, Western grasshopper sparrow.

Additional Distributional Records of Amphibians and Reptiles in Kansas Counties

JOE A. TIHEN, University of Kansas, Lawrence, Kan.

A considerable amount of unpublished locality data have been brought together recently and these are incorporated herein. In this connection I am indebted to Mr. C. D. Bunker, curator of birds and mammals of the Kansas University Museum, for permission to secure data from the specimens under his care; to Dr. Hobart M. Smith for various distributional data (including amphibian records secured in exchange for previously reported reptile records from Dr. Charles E. Burt in 1933); and to Dr. Edward H. Taylor and C. W. Hibbard for additional assistance.

LIST OF SPECIES

AMPHIBIANS

Ambystoma tigrinum mavortium (Baird)

BARBER: Lake City (C. E. Burt); 1 mi. W. of Sunnyside school, in cave (KU 19875, A. B. Leonard); 4 mi. N. of Aetna (KU 19876, C. W. Hibbard).

HAMILTON: 2 mi. N. of Coolidge (KU 20272-20273, C. W. Hibbard). (Two larvae in a small pond on June 30, 1936).

HARPER: 1 mi. S. of Harper (KU 19487, Joe Tihen).

WALLACE: Wallace (KU 20281-20282, Joe Tihen).

Necturus maculosus maculosus (Rafinesque)

ANDERSON: Welda, 4 mi. E. of Garnett (KU 19575, A. E. Brecheisen).

CHASE: 1 mi. from Matfield Green, South Fork of Cottonwood river (KU 20629, V. L. Carter).

Scaphiopus bombifrons Cope

BARBER: 1 mi. SW. of Aetna (KU 20006-20028, C. W. Hibbard); Wells Ranch (KU 20211, C. W. Hibbard).

CLARK: Stephenson Ranch (KU 20230 & 20232, Hibbard & Tiemeier).

COWLEY: 2 mi. SE. of Winfield (C. E. Burt).

DOUGLAS: North Lawrence (KU 20170-20190, Pastor Echávez).

HAMILTON: 1 mi. E. of Coolidge (KU 20274, Joe Tihen).

HARPER: Harper (KU 20169, Joe Tihen).

MEADE: 1 mi. W. of State Lake (KU 20323-20324, Hibbard & Tihen).

SEWARD: 4 mi. N. of Liberal (KU 20240-20254, Joe Tihen); 1 mi. E. of Liberal (KU 20255-20257, Parks & Tihen).

On June 26, 1936, a great number of these toads were found around a small rain pond in Seward county. The specimens taken at this time were all very small, and had scarcely lost their tails. There were literally hundreds of little toads under cow chips and small piles of drift on the muddy ground surrounding the pond. Several specimens were taken in Stevens county the next day under very similar conditions.

STEVENS: 11 mi. E. of Hugoton (KU 20259-20262, Joe Tihen).

THOMAS: 5 mi. S. of Brewster (KU 18867-18879, C. A. Campbell).

WALLACE: Lacey Ranch (KU 20297, Joe Tihen).

Bufo americanus americanus (Holbrook)

CHAUTAUQUA: 3 mi. S. of Cedarvale (C. E. Burt).

Bufo cognatus Say

BARBER: 1 mi. N. of Aetna (KU 20043-20044, O. W. Tiemeier).
BUTLER: 6 mi. S. of El Dorado (KU 18419, H. M. Smith).
COMANCHE: Schwarz Canyon (KU 20217, C. W. Hibbard).
COWLEY: 11 mi. SW. of Winfield (C. E. Burt).
DOUGLAS: K. U. Campus (KU 19768, H. M. Smith); North Lawrence (KU 20397-20409, Pastor Echávez).
FORD: 1 mi. S. of Kingsdown (KU 20283, O. W. Tiemeier).
HAMILTON: 1 mi. E. of Coolidge (KU 20271, Joe Tihen).
HARPER: 1 mi. N. of Harper (KU 20084, Joe Tihen).
MARSHALL: Blue Rapids (C. E. Burt).
MEADE: 6 mi. N. of Meade (KU 20286, C. W. Hibbard).
ROOKS: Stockton (KU 20165-20167, Ralph Imler).
SEDGWICK: Wichita (KU 20285, Sam Tihen).
SEWARD: 4 mi. N. of Liberal (KU 20264, Joe Tihen).
THOMAS: Brewster (KU 19103, C. A. Campbell).

The Seward county specimen was found at the same time and under the same conditions as the Scaphiopus from the same county mentioned above, and, like them, was scarcely out of the larval stage. Dr. Charles E. Burt has presented the following notes on the specimens from Cowley county: ". . . dug from holes in bare spots in sandy areas; each dwelling of a toad was in the form of a question mark with the entry from the long end and the resting place was formed as an expansion at the short end, which was large enough to easily accommodate the toad; the sand surrounding this resting place was packed, but moist." The Butler county specimen was taken in a cave, between seven hundred and eight hundred feet from the entrance.

Bufo punctatus Baird and Girard

CLARK: Stephenson Ranch (KU 20233, Joe Tihen).

Bufo woodhousii woodhousii (Girard)

CHEYENNE: 14 mi. E. of St. Francis (KU 20299-20301, Tiemeier & Tihen).
CLARK: Stephenson Ranch (KU 20222, C. W. Hibbard).
HAMILTON: 1 mi. E. of Coolidge (KU 20265-20267, Joe Tihen).
HARPER: 1 mi. N. of Harper (KU 17925-17926, Joe Tihen); 4 mi. SE. of Harper (KU 18943, Joe Tihen).
OSBORNE: Osborne (KU 20298, C. W. Hibbard).
WICHITA: 9 mi. SE. of Leoti (KU 20276-20277, Joe Tihen).

Acris gryllus (Le Conte)

ALLEN: 1½ mi. S. of La Harpe (KU 20609-20628, Preble, Tiemeier & Leonard).
DICKINSON: 4 mi. NW. of Herington (C. E. Burt).
FINNEY: 2 mi. E. of Essex (C. E. Burt).
MARION: 3 mi SE. of Antelope (C. E. Burt).
NEOSHO: 1½ mi. SW. of Erie (KU 20630-20631).
ROOKS: 3 mi. W. of Stockton (KU 20531-20597, Ralph Imler).

Pseudacris clarkii (Baird)

BARBER: Havard Cave (KU 19187, A. B. Leonard).
COWLEY: 2 mi. SE. of Winfield (KU 19183-19184, C. E. Burt).
FORD: 1 mi. S. of Kingsdown (KU 20284, C. W. Hibbard).
HARPER: ½ mi. N. of Harper (KU 20352-20354, Joe Tihen).

Pseudacris triseriata (Wied)

CHASE: 2 mi. SW. of Matfield Green (C. E. Burt); 3 mi S. of Cottonwood Falls (C. E. Burt).
ELLSWORTH: 12 mi. NE. of Frederick (C. E. Burt).
LINN: 5 mi. SE. of Fontana (KU 20361-20365, Tiemeier & Leonard).
MARION: 5 mi. SE. of Antelope (C. E. Burt).
MORRIS: 1 mi. SW. of Council Grove (C. E. Burt).
PRATT: Pratt (C. E. Burt).

Rana catesbeiana Shaw

HAMILTON: 1 mi. E. of Coolidge (KU 20319, C. W. Hibbard).
HARPER: Harper (KU 18555, Joe Tihen).
LOGAN: Vincent Ranch (KU 20296, C. W. Hibbard).
RAWLINS: 2 mi. NE. of Ludell (KU 20320, O. W. Tiemeier).
RENO: 2½ mi. of E. of Penalosa (C. E. Burt).

While not at all abundant in the northwestern part of the state, the bullfrog appears to be fairly common around some of the streams of this section, especially in the ponds of the Smoky Hill river. One large specimen was taken from a small pond formed by an artesian well in Hamilton county.

Rana pipiens Schreber

CHEYENNE: 14 mi. NE. of St. Francis (KU 20302, Joe Tihen).
HAMILTON: 1 mi. E. of Coolidge (KU 20269-20270, Joe Tihen).
RAWLINS: 2 mi. NE. of Ludell (KU 20288-20289, Hibbard & Tihen).
SEWARD: 1 mi. E. of Liberal (KU 20258, Joe Tihen).
SHERMAN: 17 mi. SE. of Goodland (KU 20290, C. W. Hibbard).
WICHITA: 9 mi. SE. of Leoti (KU 20275, C. W. Hibbard).

Microhyla olivacea (Hallowell)

BARBER: Wells Ranch (KU 20214, C. W. Hibbard).
CLARK: Stephenson Ranch (KU 20223-20224, Joe Tihen).
ELLSWORTH: 3 mi. SE. of Ellsworth (C. E. Burt).
GEARY: 1 mi. SW. of Junction City (C. E. Burt).
WILSON: 2 mi. E. of Buffalo (C. E. Burt).

On June 5, 1936, two Microhyla were heard calling in a small rain pond on the Wells Ranch in Barber county, but only one of these was located. On June 9, two small specimens were found under a cow chip on a dry hillside in Clark county.

LIZARDS

Crotaphytus collaris collaris (Say)

DICKINSON: (KU 16206-16215, Smith & Taylor).
LYON: 15 mi. SW. of Emporia (KU 20395-20396, D. H. Dunkle).
MEADE: 1 mi. W. of State Lake (KU 20234, Joe Tihen).
OTTAWA: SW. of Ada (KU 16914-16919, K. U. Herp. Class).

Holbrookia maculata maculata (Girard)

FINNEY: 5 mi. S. of Garden City (KU 17544-17547, H. M. Smith).
HARPER: 3 mi. S. of Harper (KU 18532, Joe Tihen).
MEADE: 1 mi. W. of State Lake (KU 20235-20236, Joe Tihen).
ROOKS: Stockton (KU 20356, Ralph Imler).

Sceloporus consobrinus consobrinus (Baird and Girard).

CLARK: Stephenson Ranch (KU 20227, Joe Tihen).
DOUGLAS: 1½ mi. N. of Cameron's Bluff (KU 17300-17303, Leonard & Hibbard; KU 17427-17439, E. H. Taylor and party).
MEADE: 1 mi. W. of State Lake (KU 20237-20239, Joe Tihen).
NORTON: 4 mi. SE. of Dinsmore (KU 15259-15260, C. W. Hibbard).
PRATT: Pratt (KU 14935, E. H. Taylor).
ROOKS: Stockton (KU 20355, Ralph Imler).
SEWARD: 1 mi. E. of Arkalon (KU 20133, Long & Hastie).

Although this lizard is very common throughout the western and central portions of the state, it was not known to occur in Kansas east of the Flint Hills until four specimens were taken in Douglas county in June, 1933, near the Kaw river on a large sand bar, in parts grown over by willows. The next month a series of this species was taken in the same general vicinity. It was found established in this area, being represented by both adult and young specimens. It probably reached this area by the flood waters of the Kaw.

Phrynosoma cornutum (Harlan)

MEADE: 1 mi. W. of State Lake (KU 20328, C. W. Hibbard).
PHILLIPS: 4 mi. S. of Glade (KU 18601-18603, C. A. Campbell).

Cnemidophorus sexlineatus (Linné)

CLARK: Stephenson Ranch (KU 20226, Joe Tihen).
FINNEY: 5 mi. S. of Garden City (KU 17588, H. M. Smith).
MEADE: 1 mi. W. of State Lake (KU 20322, Joe Tihen).
SALINE: Brooksville (KU 17230, H. M. Smith).

Leiolopisma unicolor (Harlan)

HARPER: 7 mi. SW. of Norwich (KU 18539, Joe Tihen).
JEFFERSON: 10 mi. N. of Lawrence (KU 13930-13933).
KINGMAN: 2 mi. N. of Adams (KU 17973, Joe Tihen).
LEAVENWORTH: 7 mi. NE. of Lawrence (KU 8691, Henry Burt).
LINN: Near La Cygne (KU 13929, E. H. Taylor).

On September 10, 1933, one of these tiny lizards was found under a layer of dry leaves along the bank of the Chikaskia river in Kingman county. On

June 13, 1934, another one was taken under similar conditions near the same river in Harper county.

Eumeces fasciatus (Linné)

NESS: Ranson (KU 18417-18418, John Schoeppel).
OSAGE: 4 mi. S. of Carbondale (KU 17231-17236, D. H. Dunkle); 3 mi. S. of Carbondale (KU 18451-18456, D. H. Dunkle).

Two specimens of this lizard were found in Ness county on January 13, 1934, eight feet under the ground.

Eumeces septentrionalis septentrionalis (Baird)

COMANCHE: Schwarz Canyon (KU 20330-20331, C. W. Hibbard).
LINN: 5 mi. SE. of Fontant (KU 20360, Preble, Tiemeier, & Leonard).
OSAGE: 4 mi. S. of Carbondale (KU 17095 & 17148, D. H. Dunkle).

On June 7, 1936, two of these lizards were found under small brush piles in Schwarz canyon, Comanche county. These two specimens are apparently intergradations between this form and the southern subspecies, *E. s. obtusirostris* (Bocourt). Their coloration is more nearly that characteristic of obtusirostris, but their scale characteristics more closely resemble those of typical septentrionalis.

SNAKES

Leptotyphlops myopica (Garman)

CLARK: Stephenson Ranch (KU 20206, C. W. Hibbard).
MEADE: 1 mi. W. of State Lake (KU 20207, Kline).

On June 12, 1936, C. W. Hibbard found one of these tiny, rare snakes beneath a rock on a hillside near the proposed Clark county state lake on the Stephenson Ranch. On June 18, Kline, CCC foreman in the Meade county state park, found one in the park territory. Originally reported by Hibbard as *Leptotyphlops dulcis* (Baird and Girard) (Copeia, I. 1937, p. 74.)

Carphophis amoena vermis (Kennicott)

WYANDOTTE: 3 mi. E. of Bonner Springs (KU 2278, White & Taylor).

Diadophis punctatus arnyi (Kennicott)

BUTLER: Whitewater (KU 18020, Woods).
CLARK: Stephenson Ranch (KU 20210, C. W. Hibbard).
GREENWOOD: 8 mi. S. of Eureka (KU 17083-17091, Tihen & Willy).
SUMNER: 3 mi. N. of Oxford (KU 18984, Leonard & Long).

Heterodon contortrix (Linné)

GREENWOOD: Near Fall River (KU 18115, Dougan).

Heterodon nasicus Baird and Girard

CLARK: Stephenson Ranch (KU 20314, C. W. Hibbard).
COMANCHE: 9 mi. E. of Coldwater (KU 20313, Joe Tihen).
GREELEY: (KU 18059, D. H. Dunkle).
GREENWOOD: 8 mi. SW. of Toronto (KU 20321, C. E. Hibbard).
LOGAN: Vincent Ranch (KU 20304, Joe Tihen).

MEADE: 1 mi. W. of State Lake (KU 20306, C. W. Hibbard).
PHILLIPS: 4 mi. S. of Glade (KU 18930, C. A. Campbell).

Opheodrys aestivus (Linné)

GREENWOOD: 4 mi. NE. of Fall River (KU 19264, Paul Hibbard).
WILSON: Near Benedict (KU 18055, C. T. Brandhorst).

Coluber constrictor flaviventris (Say)

DONIPHAN: (KU 7389, T. E. White).
JOHNSON: 3 mi. E. of De Soto (KU 17174-17175, W. S. Long).
KINGMAN: 6 mi. SW. of Norwich (KU 18346, Joe Tihen).
OSAGE: 5 mi. NE. of Carbondale (KU 19217, H. M. Smith); 1½ mi. NE. of Carbondale (KU 19713, D. H. Dunkle).

Masticophis flagellum flavigularis (Hallowell)

COMANCHE: Schwarz Canyon (KU 20312, C. W. Hibbard).
HAMILTON: 1 mi. E. of Coolidge (KU 20318, Dean Conard).
HARPER: 3½ mi. N. of Harper (KU 19333, Joe Tihen).

Elaphe obsoleta obsoleta (Say)

GREENWOOD: 8 mi. SW. of Toronto (KU 17173, C. E. Hibbard); 4 mi. NE. of Fall River (KU 19362, C. W. Hibbard).
SUMNER: 3 mi. N. of Oxford (KU 18886, Leonard & Long).

Arizona elegans elegans (Kennicott)

HAMILTON: Near Syracuse (KU 20097, P. D. Evans).

Pituophis sayi sayi (Schlegel)

LINCOLN: 4 mi SW. of Sylvan Grove (KU 17497, C. W. Hibbard).
LYON: E. of Allen city limits (KU 19866, C. W. Hibbard).
NORTON: 8 mi. W. of Norton (KU 14154, C. W. Hibbard).

Lampropeltis calligaster (Harlan)

CLARK: Stephenson Ranch (KU 20315, Joe Tihen).

A partially digested specimen of a king snake of this species was found in the stomach of a Great Horned Owl (*Bubo virginianus pallescens* Stone) taken one mile east of Coolidge, in Hamilton county, June 30, 1936.

Lampropeltis getulus holbrooki (Stejneger)

CHASE: 12 mi. W. of Staffordville (KU 17901, Smith, Leonard, & Hibbard).
GREENWOOD: 9 mi. SW. of Toronto (KU 16289, Hibbard & Dunkle).
JOHNSON: 6 mi. E. of Eudora (KU 17389, W. K. McNown).

Lampropeltis triangulum syspila (Cope)

JEFFERSON: (KU 8388, E. H. Taylor).
LEAVENWORTH: 7 mi. N. of Lawrence (KU 3489, D. K. Lahmen).

Hypsiglena ochrorhynchus Cope

CLARK: Stephenson Ranch (KU 20208-20209, Hibbard & Tihen).

On June 12, 1936, C. W. Hibbard found two Hypsiglena, a male and a female, under rocks on the Stephenson Ranch, in the same vicinity that the Leptotyphlops was found. On June 14, an immature specimen was taken about the same place. They were all under rocks near the top of a hill. These are apparently the first specimens of this species to be taken in Kansas.

Natrix grahamii (Baird and Girard)

COFFEY: ½ mi. E. of Waverly (KU 19440, Joe Tihen).

Natrix rhombifera (Hallowell)

HARPER: 1 mi. N. of Harper (KU 17818, Joe Tihen).

Natrix sipedon sipedon (Linné)

HARVEY: 4 mi. SW. of Walton (KU 17986, A. B. Leonard).
POTTAWATOMIE: 2 mi. N. of Westmoreland (KU 17455, K. U. Herp. Class).
SUMNER: 1½ mi. S. of Argonia (KU 19335, Joe Tihen).

Natrix erythrogaster transversa (Hallowell)

HARPER: 1 mi. N. of Harper (KU 18342, Joe Tihen).

Storeria dekayi (Holbrook)

GREENWOOD: 8 mi. SW. of Toronto (KU 18016, C. W. Hibbard).
KINGMAN: 6 mi. SW. of Norwich (KU 19436, Joe Tihen).
OSAGE: 5 mi. NE. of Carbondale (KU 19221, H. M. Smith).
POTTAWATOMIE: Flush (KU 17097, H. M. Smith).
WILSON: Benedict (KU 18127, W. S. Long).

This species, while fairly common in the eastern part of the state, is seldom found west of the Flint Hills. On June 10, 1934, a single specimen was found in a small brush pile near the Chikaskia river in Kingman county.

Virginia valeriae elegans Kennicott

LEAVENWORTH: 20 mi. N. of Lawrence (KU 7344-7345, C. D. Bunker).

Tropidoclonion lineatum (Hallowell)

SEDGWICK: Wichita (KU 20329, Sam Tihen).

Thamnophis marcianus (Baird and Girard)

SEWARD: 1 mi. E. of Liberal (KU 20264, Joe Tihen).

On June 26, 1936, two specimens of this comparatively rare garter snake were taken around the edges of a lake east of Liberal, but one of these was lost.

Thamnophis radix (Baird and Girard)

KINGMAN: 6 mi SW. of Norwich (KU 17918, Joe Tihen).
LOGAN: Vincent Ranch (KU 20311, O. W. Tiemeier).
SHERMAN: 17 mi. SE. of Goodland (KU 20292-20295, Hibbard, Tiemeier, & Tihen).

Thamnophis sauritus proximus (Say)

KINGMAN: 6 mi. SW. of Norwich (KU 18006, Joe Tihen).

Thamnophis sirtalis parietalis (Say)

CHASE: Elmdale (KU 18442, Burtone Risser).
HARPER: 3 mi. NE. of Danville (KU 20357, Joe Tihen).

Tantilla gracilis Baird and Girard

ANDERSON: 4 mi. N. of Garnett (KU 16271-16275, Taylor & Dunkle); Cedar creek (KU 16364-16370, Taylor & Dunkle).
GREENWOOD: 1 mi. S. of Eureka (KU 17069-17082, Tihen & Willy).

Tantilla nigriceps Kennicott

NESS: (KU 18415-18416, John Schoeppel).
RUSSEL: Sylvan Grove (KU 17603, C. T. Brandhorst).

The two specimens from Ness county were found eight feet under the ground, on January 13, 1934.

Agkistrodon mokasen mokasen (Beauvois)

WILSON: Near Benedict (KU 18045, C. T. Brandhorst).

Sistrurus catenatus catenatus (Rafinesque)

ANDERSON: Garnett (KU 19867-19871, T. E. White).
POTTAWATOMIE: 10 mi. NE. of Manhattan (KU 17900, H. M. Smith).

Crotalus confluentus confluentus (Say)

SEWARD: (KU 19712, W. S. Long).

Crotalus horridus Linné

OSAGE: 5 mi. NE. of Carbondale (KU 19220, D. H. Dunkle; KU 19282, H. M. Smith).

TURTLES

Sternotherus odoratus (Latreille)

GREENWOOD: 1 mi. E. of Climax (KU 17122, Tihen & Willy).

Kinosternon flavescens (Agassiz)

HARPER: 1 mi. N. of Harper (KU 18157-18161, Joe Tihen).
LOGAN: 3 mi. S. of Elkader (KU 3753-3754, T. E. White).
PHILLIPS: 4 mi. S. of Glade (KU 19480, C. A. Campbell).

Chelydra serpentina (Linné)

CLOUD: (KU 18308, C. W. Hibbard).
COMANCHE: Schwarz Canyon (KU 18384, C. W. Hibbard).
GREENWOOD: 8 mi. SW. of Toronto (KU 18361, C. W. Hibbard; KU 20341, Olin Hibbard).
RAWLINS: 2 mi. NE. of Ludell (KU 20339, Joe Tihen).
SHERMAN: 17 mi. SE. of Goodland (KU 20291, C. W. Hibbard).

Terrapene ornata (Agassiz)

CLARK: Stephenson ranch (KU 20332, Joe Tihen).
HARPER: 1 mi. N. of Harper (KU 17218-17219, Sam Tihen).
LINCOLN: SW. of Sylvan Grove (KU 17216, W. S. Long).
LOGAN: 5 mi. W. of Elkader (KU 3539-3540, T. E. White).
PHILLIPS: 4 mi. S. of Glade (KU 19479 & 19481, C. A. Campbell).
SEWARD: 1 mi. E. of Arkalon (KU 19337-19338, W. S. Long).

Terrapene triunguis (Agassiz)

BOURBON: 13 mi. S. of Fort Scott (KU 19348, J. D. Black).
CRAWFORD: 21 mi. N. of Pittsburg (KU 19340, J. D. Black); Opolis (KU 19351, Ruby Black).

Chrysemys picta bellii (Gray)

CLOUD: W. of Miltonvale (KU 17360, C. W. Hibbard).
HARPER: 1 mi. N. of Harper (KU 18162 & 18336, Joe Tihen).
KINGMAN: ½ mi. W. of Runnymede (KU 18351-18352, Sam Tihen).
LOGAN: Vincent ranch (KU 20335-20338, C. W. Hibbard).
OSAGE: 1 mi. S. of Carbondale (KU 17569, D. H. Dunkle).

Pseudemys troostii (Holbrook)

CLARK: Stephenson ranch (KU 20333, Joe Tihen).
COMANCHE: Schwarz canyon (KU 18364, C. W. Hibbard).
DOUGLAS: Lake View (KU 17356, K. U. Herp. Class).
HARPER: 1 mi. N. of Harper (KU 18345, Joe Tihen).

Amyda spinifera (Le Sueur)

HARPER: 1 mi. N. of Harper (KU 18159, Joe Tihen).

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GERMANY

Frankfurt a M.: Senckenbergische Naturforschende Gesellschaft. Natur und Volk.
Kiel und Leipzig: Naturwissenschaftlicher Verein für Schleswig-Holstein. Schriftten.
Munchen und Wiesbaden: Nassuischer Verein für Naturkunde. Jahrbucher.

GREAT BRITAIN

England, Cambridge: Cambridge Philosophical Society. Biological Reviews.
England, Cambridge: Imperial Bureau of Plant Genetics (for crops other than herbage) Plant breeding abstracts, Pt. 1, British Empire section.
England, Harpenden: Imperial Bureau of Soil Science. Technical communication.
England, Liverpool: Liverpool Geological Society. Proceedings.
England, Manchester: Manchester Literary and Philosophical Society. Memoirs and proceedings.
England, Southampton: Society for British Entomology. Journal; Transactions.
England, Wye: South-Eastern Agricultural College. Journal; Reprints; Department of Economics, Reports.
Scotland, Edinburgh: Botanical Society of Edinburgh. Transactions and proceedings.
Scotland, Edinburgh: Royal Society of Edinburgh. Proceedings.
Scotland, Glasgow: Royal Philosophical Society of Glasgow. Proceedings.
Wales, Aberystwyth: Imperial Bureau of Plant Genetics: Herbage Plants. Bulletin.

GREECE

Athens: Universitatis Atheniensia. Institut et Musée Zoologique. Acta.

ITALY

Bologna: R. Accademia delle Scienze dell 'Instituto di Bologna. Classe di Scienze Fisiche; Memorie; Rendiconto.
Catania: Accademia Gioenia di Scienze Naturali in Catania. Bollettino delle sedute.
Stato della Citta del Vaticano: Accademia Pontificia delle Scienze Nuovi Lincei. Annuario; Atti; Memorie; Scientiarum nuncius radiophonicus.
Torino: R. Accademia delle Scienze di Torino. Atti.

JAPAN

Kyoto: Takeuchi Entomological Laboratory. Tenthredo: Acta entomologica.
Sapporo: Sapporo Natural History Society. Transactions.
Tokyo: Tokyo Bunrika Daigaku (Tokyo University of Literature and Science). Science reports.

MEXICO

Mexico, D. F.: Academia Nacional de Ciencias Antonio Alzate. Memorias; Revista. Instituto de Geologico, Anales. Universidad Nacional. Instituto de Biologia. Anales.
San Jacinto: Secretaria de Agricultura y Fomento. Boletin mensual.

NORWAY

Oslo: Norske Videnskaps-Akademi i Oslo. Arbok; Avhandlinger. Matematisk-naturvidenskabelig Klasse.
Trondhjem: K. Norske Videnskabs Selskab. Forhandlinger; Schrifter; Museet; Aarsberetning; Oldsaksamlingens tilvekst.

PORTUGAL

Lisbon: Universidade L'Institut d'Anatomie. Arquivo de anatomia e antropologia.

SPAIN

Barcelona: R. Academia de Ciencias y Artes de Barcelona. Boletin; Memorias.
Madrid: Academia de Ciencias Exactas, Fisicas y Naturales de Madrid. Anuario; Boletin; Discursos leidos; Memorias; Revista.

SWEDEN

Lund: K. Fysiografiska Sallskapet. (Royal Physiographic society.) Forhandlinger.
Upsala: Universitets. Arsskrift.

SWITZERLAND

Basel: Naturforschende Gesellschaft in Basel. Verhandlungen.
Neuchatel: Société Neuchateloise de Geographie. Bulletin.

U. S. S. R.

Leningrad: Institute of Plant Industry. Bulletin of applied botany, genetics and plant breeding.
Perm: Institut des Recherches Biologiques. Bulletin.

UNITED STATES AND POSSESSIONS

Alabama, Birmingham: Alabama Academy of Science. Journal.
Arizona, Flagstaff: Lowell observatory. Bulletin.
Arizona, Tucson: University of Arizona. Fine arts bulletin; General bulletin; Humanities bulletin; Social science bulletin.
California, Berkeley: University of California. Bulletin; Publications in geological sciences; Publications in physiology. Agricultural Experiment Station, Bulletin; Circular; Hilgardia; Report. Agricultural Extension Service, Circular.
California, Buena Park: Cooper Ornithological Club. Condor.
California, Claremont: Pomona College. Journal of entomology and zoölogy.
California, San Francisco: California Academy of Science. Occasional papers; Proceedings.
Colorado, Boulder: Colorado-Wyoming Academy of Science. Journal; Social sciences in Colorado-Wyoming. Bulletin.
Colorado, Denver: Colorado Museum of Natural History. Annual Report; Proceedings.
Colorado, Denver: Colorado Scientific Society. Proceedings.
Connecticut, Hartford: State Geological and Natural History Survey. Bulletin.
Connecticut, New Haven: Connecticut Academy of Arts and Sciences. Memoirs; Transactions.
Florida, Tallahassee: State Geological Survey. Annual report; Bulletin.
Georgia, Atlanta: Geological Survey. Bulletin.

Illinois, Chicago: Chicago Academy of Sciences. Bulletin; Program of activities.
Illinois, Springfield: Illinois State Academy of Science. Transactions.
Illinois, Urbana: Illinois Department of Registration and Education, Division of Natural History Survey. Bulletin.
Indiana, Bloomington: Indiana University. Publications; Science series; Studies; School of Education, Bulletin; Extension Division, Bulletin.
Indiana, Indianapolis: Butler University. Botanical Studies; Papers.
Indiana, Notre Dame: American Midland Naturalist.
Iowa, Ames: Iowa State College. Journal of Science.
Iowa, Iowa City: University of Iowa. Studies; Series on aims and progress of research; Studies in natural history.
Kentucky, Lexington: Kentucky Academy of Science. Transactions.
Louisiana, Baton Rouge: Louisiana Academy of Science. Proceedings.
Louisiana, New Orleans: Louisiana State Museum. Biennial report.
Massachusetts, Boston: American Academy of Arts and Sciences. Proceedings; Reprints.
Massachusetts, Boston: Boston Society of Natural History. Memoirs.
Massachusetts, Boston: New England Museum of Natural History. Bulletin; Occasional papers; Proceedings.
Michigan, Ann Arbor: Michigan Academy of Science. Transactions.
Michigan, Ann Arbor: University of Michigan. Laboratory of Vertebrate Genetics, Contributions. Museum of Paleontology, Contributions. Museum of Zoölogy, Miscellaneous publication; Occasional papers.
Michigan, Lansing: Michigan Historical Commission. Bulletin; Michigan history magazine.
Missouri, Columbia: University of Missouri. Studies; Observatory Publications.
Missouri, St. Louis: Academy of Science of St. Louis. Transactions.
Nebraska, ...oln: University of Nebraska. Science reports; University studies.
New York, ...y: New York State University. Bulletin.
New York, Buf... : Buffalo Society of Natural History. Bulletin.
New York, New York: New York Academy of Sciences. Annals.
New York, Rochester: Rochester Academy of Sciences. Proceedings.
New York, Staten Island: Institute of Arts and Sciences. Proceedings.
New York, Syracuse: Roosevelt Wild Life Forest Experiment Station. Roosevelt wild life annals; Roosevelt wild life bulletin.
North Carolina, Chapel Hill: Elisha Mitchell Scientific Society. Journal.
Ohio, Cincinnati: Lloyd Library. Bulletin; Circular.
Ohio, Cleveland: Museum of Natural History. Pocket natural history; Scientific Publications.
Ohio, Columbus: Ohio State University. Bulletin; Contributions from the Department of Zoology and Entomology; University studies.
Ohio, Oberlin: Oberlin College. Laboratory bulletin.
Oklahoma, Stillwater: Oklahoma Agricultural and Mechanical College.
Oregon, Eugene: University of Oregon. Geological series; Plant biology series.
Pennsylvania, Harrisburg: Pennsylvania Academy of Science. Proceedings.
Pennsylvania, Philadelphia: Academy of Natural Sciences. Proceedings; Review.
Pennsylvania, Philadelphia: Numismatic and Antiquarian Society. Proceedings.
Pennsylvania, Pittsburg: Carnegie Institute Museum. Annals; Annual report; Memoirs.
Pennsylvania, Pittsburg: Carnegie Library.
Pennsylvania, Pittsburg: Wistar Institute of Anatomy. Bulletin.
Pennsylvania, State College: Pennsylvania State College. Studies.
Philippine Islands, Laguna: University of the Philippines. College of Agriculture.
Philippine Islands, Manila: Philippine Islands Bureau of Science. Annual report; Mineral resources.
South Carolina, Columbia: South Carolina Academy of Science. Bulletin.
Tennessee, Nashville: Tennessee Academy of Science. Journal.
Texas, San Antonio: Scientific Society of San Antonio. Annual report.
Washington, D. C.: National Academy of Sciences. Memoirs; Publications.
Washington, D. C.: National Research Council. Bulletin Organization and members; Report.
Washington, D. C.: United States Department of Agriculture.
Washington, D. C.: United States Geological Survey.

West Virginia, Morgantown: West Virginia Academy of Science. Proceedings.
Wisconsin, Madison: Wisconsin Academy of Sciences. Transactions.
Wisconsin, Madison: Wisconsin Geological and Natural History Survey. Bulletin.
Wisconsin, Milwaukee: Public Museum. Bulletin; Yearbook.

YUGOSLAVIA

Belgrade: L'Académie des Sciences Mathematiques et naturelles. (Académie Royale Serbe.) Bulletin.

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ARGENTINA

Buenos Aires: Boletin Matematico, Universidad de Buenos Aires.
La Plata: Universidad Nacional de La Plata.
Santa Fe: Sociedad Cientifica de Santa Fe.

AUSTRALIA

Melbourne: Council for Scientific and Industrial Research.
Melbourne: Department of Mines, Geological Survey of Victoria.
New South Wales, Sydney: Geographical Society of New South Wales.
Perth: Government Geologist.

BELGIUM

Louvain: Societe Scientifique de Bruxelles.

BRAZIL

Rio De Janeiro: Director do, Instituto de Biologia Vegetal.

CANADA

Nova Scotia, Halifax: Department of Public Works and Mines.
Ottawa: Department of Agriculture. Department of the Interior; Director, Mines Branch, Department of Mines; Library, Geological Survey of Canada.
Quebec: Societe de Geographie de Quebec.

CHINA

Canton: Lingnan Science Journal.
Hangchow, West Lake: Bureau of Entomology of Chekiang.
Peiping: Hsi-tzeu-men-wai. Institute of Physiology.
Shanghai: Academia Sinica.

CZECHOSLOVAKIA

Prague: Ceske Spolecnosti Entomologieke.

ENGLAND

London: Librarian, Geological Society, Burlington House.
Librarian, London Mathematical Society.
Manchester: John Rylands Library.

FINLAND

Helsinki: Academiae Scientiarum Fennicae.
Helsingfors: Societas Scientiarum Fennica.

FRANCE

Caen: Societe Linneenne de Normandie.
La Havre: Societe Havraise d' Etudes Diverses.
La Rochelle: Bibliotheque Scientifique.
La Rochelle: Societe des Sciences naturelles de la Charente-Inferieure.
Paris: Universite de Paris.
Toulouse: Academie des Sciences Inscriptions et Belles-Lettres de Toulouse.

GERMANY

Berlin: Botanischen Vereins der Provinz Brandenburg; Deutsch-Ausländischer Buchtausch; Deutsche Geologische Gesellschaft; Notgemeinschaft der Deutschen Wissenschaft; Preussische Akademie der Wissenschaften.
Bremen: Naturwissenschaftlicher Versin.
Chemnitz: Naturwissenschaftliche Gesellschaft.
Dresden: Die Naturwissenschaftliche Gesellschaft. Isis.
Hallea: Naturwissenschaftlichen Vereins für Sachsen und Thüringen.

HOLLAND

Utrecht: Provinciall Utrechtsch Genootschap van Kunsten en Wetenschappen te.

INDIA

Madras: Connemara Public Library.
Naggar, Kulu, Punjab: Institute of Roerich Museum.

IRELAND

Dublin, Ballsbridge: Royal Dublin Society.

ITALY

Genoa: R. Universita di Genova, Istituto di Zoologia.
Milan: Universitá. Laboratoria di Zoologia Agraria e Bachicoltura.
Modena: Reale Accademia di Scienze Lettere ed Arti.
Pisa: Societa Toscana di Scienze Naturali.

JAPAN

Sapporo: Faculty of Science, Hakkaido Imperial University.
Sendai: Tohoku Imperial University.

MEXICO

Col. Anahuac, D. F.: Instituto Biotecnico.
Mexico, D. F.: Universidad de Mexico.

NORWAY

Bergen: Chr. Michelsens Institut.
Oslo: Bibliotheque de l'universite Royale.
Stavanger: Stavanger Museum.

PERU

Lima: Sociedad Geologica del Peru.

PHILIPPINE ISLANDS

Manila: National Library. (Public Documents Section.)

SCOTLAND

Edinburgh: Botanical Society of Edinburgh.

SOUTH AFRICA

Bloemfontein: Nasionale Museum.

SWEDEN

Stockholm: Entomologischer Venein.

SWITZERLAND

Geneva: Societe de Physique et d'Histoire Naturelle.

U. S. S. R.

Leningrad: Library of the Academy of Sciences of the U. S. S. R.
Akademie der Wissenschaften der Union der Sozialistichen Sowjet-Republiken.
Comite Geologique.
Institut d'Analyse Physico-chimique.
Societe Russe de Mineralogie.
Institute du Platine et des Autres Metaux Precieux.
Kiev: Academie des Sciences d'Ukraine.
Perm: Scientific Memoirs. University of Perm.
Tomsk: Tomsk State University, Wissenschaftliche Berichte.

URUGUAY

Montivideo: Museo de Historia Natural de Montevideo.
Montevideo: Sociedad de Biologia de Montevideo.

HAWAII

Honolulu: Hawaii Agriculture Experiment Station.

PUERTO RICO

Mayaguez: Puerto Rico Agriculture Experiment Station.

United States

ALABAMA

University: Geological Survey of Alabama.

ARIZONA

Flagstaff: Lowell Observatory.
Tucson: University of Arizona.

CALIFORNIA

Los Angeles: University of California at Los Angeles.
Palo Alto: Stanford University.

CONNECTICUT

New Haven: Connecticut Academy of Arts and Sciences.

DISTRICT OF COLUMBIA

Washington: Division of Documents, Library of Congress; Smithsonian Institution; Library, U. S. Geological Survey; U. S. National Museum.

FLORIDA

Gainesville: University of Florida Library.

IDAHO

Moscow: University of Idaho.

ILLINOIS

Chicago: American Medical Association; University of Chicago Libraries.
Springfield: Illinois State Academy of Science, State Museum.

INDIANA

Bloomington: University of Indiana.
Indianapolis: Butler University.
Notre Dame: Notre Dame University.

IOWA

Des Moines: Iowa State Library.
Iowa City: University of Iowa.

KANSAS

Atchison: Abbey Library, St. Benedict's College.
Lawrence: State Geological Survey of Kansas, Geol. Bldg.
Pittsburg: Kansas State Teachers College.
Topeka: Kansas State Board of Agriculture; Library, Kansas State Historical Society; State Library, State House.

LOUISIANA

Baton Rouge: Louisiana Academy of Sciences, State University; Louisiana State University, Library.

MARYLAND

Baltimore: Johns Hopkins University, Library; Maryland Academy of Sciences.

MASSACHUSETTS

Boston: State Library, State House.
Cambridge: Harvard University; Peabody Museum of American Archaeology and Ethnology.
Salem: Peabody Museum.

MICHIGAN

Ann Arbor: University of Michigan.
Detroit: Detroit Public Library.
Lansing: Department of Conservation, State Gological Survey; Michigan Historical Commission.

MINNESOTA

Minneapolis: University of Minnesota.

MISSOURI

Columbia: Missouri Academy of Science.
Columbia: University of Missouri.
Rolla: Missouri Bureau of Geology and Mines.
St. Louis: Academy of Science of St. Louis, Public Library.

MONTANA

Bozeman: Montana State College Library.
Missoula: University of Montana.

NEBRASKA

Lincoln: Nebraska Academy of Science, U. of Nebraska; Conservation and Survey Division, Library; Nebraska Geological Survey, Librarian.

NEW JERSEY

Princeton: Princeton University, Library.
Trenton: Department of Conservation and Development, Geological Survey.

NEW YORK

Albany: University of the State of New York, Library.
New York: American Museum of Natural History; Columbia University, Library.

OHIO

Cincinnati: University of Cincinnati, Library.
Cleveland: Cleveland Public Library.
Columbus: Ohio Academy of Science, Ohio State University.
Granville: Denison University, Scientific Laboratories.

PENNSYLVANIA

Harrisburg: Department of Public Instruction, State Library.
Philadelphia: American Philosophical Society; Free Library of Philadelphia; University of Pennsylvania, Library.
Wilkes-Barre: Wyoming Historical and Geological Society.

RHODE ISLAND

Providence: Brown University, Library.

SOUTH DAKOTA

Rapid City: South Dakota State School of Mines, Library.

TENNESSEE

Knoxville: University of Tennessee, Library.
Nashville: Tennessee Academy of Science.

TEXAS

College Station: Texas Academy of Science.

WASHINGTON

Pullman: State College of Washington.

WEST VIRGINIA

Morgantown: West Virginia Academy of Science; West Virginia University.

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